88064842

BLM Library
D-553A, Building 50
Denver Federal Center
P. O. Box 25047
Denver, CO 80225-0047

TN
859
.C64
R564
no. 3
Sect.
1.2

Rio Blanco Oil Shale Project

PROGRESS REPORT 3

GEOTECHNICAL DATA GATHERING PROJECT

HYDROLOGIC PROGRAM
SECTION 1.2

INTERPRETIVE TEXT

BLM Library
D-553A, Building 50
Denver Federal Center
P. O. Box 25047
Denver, CO 80225-0047

To Area Oil Shale Supervisor
United States Geological Survey

by
Wright Water Engineers
for
Gulf Oil Corporation
and
Standard Oil Company (Indiana)

PROGRESS REPORT 3

GEOTECHNICAL DATA GATHERING PROJECT
HYDROLOGIC PROGRAM
SECTION 1.2

INTERPRETIVE TEXT

JULY 15, 1975

TO

AREA OIL SHALE SUPERVISOR
UNITED STATES GEOLOGICAL SURVEY

By

WRIGHT WATER ENGINEERS, INC.
For
Gulf Oil Corporation
and
Standard Oil Company (Indiana)

RBOSP PROGRESS REPORT

TABLE OF CONTENTS

INTERPRETIVE TEXT

Section No.		Page
1.2	Hydrologic Program	
1.2.1	Surface Water Monitoring Stations	1
1.2.2	Surface Water Data Collection	2
1.2.3	Alluvial Aquifers	6
1.2.4	Deep Aquifer Drilling Program	21
1.2.5	Deep Aquifer Completion Program	32
1.2.6	Upper and Lower Aquifer Pumping Tests	33
1.2.7	Deep Aquifer Monitoring	35
1.2.8	Data Input to Mathematical Model	68
1.2.9	Dewatering Analysis	69
	Appendix	

TABLE OF CONTENTS

INTERPRETIVE TEXT

Section No.		Page
1.2	Hydrologic Program	
1.2.1	Surface Water Monitoring Stations	1
1.2.2	Surface Water Data Collection	2
1.2.3	Alluvial Aquifers	6
1.2.4	Deep Aquifer Drilling Program	21
1.2.5	Deep Aquifer Completion Program	32
1.2.6	Upper and Lower Aquifer Pumping Tests	33
1.2.7	Deep Aquifer Monitoring	35
1.2.8	Data Input to Mathematical Model	68
1.2.9	Dewatering Analysis	69
	Appendix	

TABLES

Table Number		Page
1.2-1	Location and USGS Identification Numbers for Surface and Rain Gaging Stations	3
1.2-2	Data Collection Schedule for Stream Gaging Stations	4
1.2-3	Summary Water Analysis Stream Gaging Station Corral Gulch near West Line Tract C-a	9
1.2-4	Summary Water Analysis Stream Gaging Station Corral Gulch East of Tract	10
1.2-5	Summary Water Analysis Stream Gaging Station Yellow Creek near White River, Colorado	11
1.2-6	Water Quality Analysis Summary, Alluvial Aquifers	22
1.2-7	Drill Hole Completion Summary	34
1.2-8	Pumping Test Schedule	36
1.2-9	Water Quality Analysis Summary	38
1.2-9a	Summary of Qualitative Spectographic Analysis	39
1.2-10	Pumping Rates & Times	41
1.2-11	Transmissivity & Coefficient of Storage from Upper Aquifer Drawdown & Recovery Test	43
1.2-12	Transmissivity & Coefficient of Storage from Lower Aquifer Drawdown Test	45
1.2-13	Transmissivity & Coefficient of Storage from Lower Aquifer Recovery Test	46

RBOSP PROGRESS REPORT

LIST OF FIGURES

Figure Number — Page

1.2-1 Stream Gaging Station Map 5
1.2-2 Discharge and Conductivity, Corral Gulch Near West Line Tract C-a 12
1.2-3 Discharge and Conductivity, Corral Gulch East of Tract 13
1.2-4 Discharge and Conductivity, Yellow Creek near White River 14
1.2-5 Boron and Flouride, Corral Gulch near West Line Tract C-a 15
1.2-6 Boron and Flouride, Corral Gulch East of Tract C-a 16
1.2-7 Boron and Flouride, Yellow Creek near White River 17
1.2-8 Precipitation near Cathedral Bluffs 18
1.2-9 Precipitation, Stake Springs Draw 19
1.2-10 Precipitation, Yellow Creek near White River 20
1.2-11 Water Depth and Conductivity, Alluvial Hole G-S S7 24
1.2-12 Temperature and pH, Alluvial Hole G-S S7 25
1.2-13 Water Depth and Conductivity, Alluvial Hole G-S S8 26
1.2-14 Temperature and pH, Alluvial Hole G-S S8 27
1.2-15 Water Depth and Conductivity, Alluvial Hole G-S S11 28
1.2-16 Temperature and pH, Alluvial Hole G-S S11 29
1.2-17 Water Depth and Conductivity, Alluvial Hole G-S S12 30
1.2-18 Temperature and pH, Alluvial Hole G-S S12 31
1.2-19 Water Monitoring Hole Map 48
1.2-20 Pump Installation CE 701 49
1.2-21 Pump Installation CE 705A February 50
1.2-22 Pump Installation CE 705A March 51
1.2-23 Pump Installation G-S 4-5 52
1.2-24 Pump Installation G-S 12 53
1.2-25 Pump Installation TO 3 54
1.2-26 Pump Installation G-S D16 55

RBOSP PROGRESS REPORT

LIST OF FIGURES, Continued

Figure Number		
1.2-27	Pump Installation G-S D17	56
1.2-28	Pump Installation G-S D18	57
1.2-29	Pump Installation G-S D19	58
1.2-30	Water Quality Upper Aquifer Pumping Test CE 705A	59
1.2-31	Water Quality Upper Aquifer Pumping Test G-S 4-5	60
1.2-32	Water Quality Upper Aquifer Pumping Test G-S 12	61
1.2-33	Water Quality Upper Aquifer Pumping Test TO 3	62
1.2-34	Water Quality Lower Aquifer Pumping Test G-S D16	63
1.2-35	Water Quality Lower Aquifer Pumping Test G-S D17	64
1.2-36	Water Quality Lower Aquifer Pumping Test G-S D18	65
1.2-37	Water Quality Lower Aquifer Pumping Test G-S D19	66
1.2-38	Combined Water Quality G-S D18 and G-S D19	67
Plate 1	Topographic Base Map	Pocket

RBOSP PROGRESS REPORT

1.2 HYDROLOGIC PROGRAM

Rio Blanco Oil Shale Project is conducting the hydrologic program to provide the data for the following determinations: hydrologic environmental baseline; aquifer characteristics; and quality and quantity of water expected to be produced from various mining plans. To accomplish these objectives, the program has been divided into the nine tasks listed below.

1.2.1 - Surface Water Monitoring Stations
1.2.2 - Surface Water Data Collection
1.2.3 - Alluvial Aquifer Monitoring
1.2.4 - Deep Aquifer Drilling Program
1.2.5 - Deep Aquifer Completion Program
1.2.6 - Upper and Lower Aquifer Pumping Tests
1.2.7 - Deep Aquifer Monitoring
1.2.8 - Data Input to Mathematical Model
1.2.9 - Dewatering Analysis

The status or progress of each of the nine specific tasks is summarized and results for Sections 1.2.2, 1.2.3, 1.2.6 and 1.2.7 are interpreted in this text. Additional detailed information on Sections 1.2.1, 1.2.2, 1.2.3, 1.2.4 and 1.2.5 was presented in RBOSP Progress Report 2. RBOSP Progress Report 3 is divided into three major categories. They are: The Summary Report; The Interpretive Text and; Raw Data Volumes I, II, and III.

Hydrologic data collection began with the drilling and coring operations by Rio Blanco Oil Shale Project in July 1974. Previous hydrologic baseline data collected in the area is contained in "Phase II, Preliminary Dewatering Analysis Report, Cameron Engineers, November, 1972" and "Phase II, Preliminary Hydrogeologic Report for AMOCO, December, 1973," and RBOSP Progress Report 2, Section 1.2 Hydrologic Program. Wright Water Engineers, Inc., Denver, Colorado, has been compiling the hydrologic data on behalf of Rio Blanco Oil Shale Project.

1.2.1 SURFACE WATER MONITORING STATIONS

The Rio Blanco Oil Shale Project has contracted with the Colorado River Water Conservation District to have the Water Resources Division of the U. S. Geological Survey build and operate seven surface gaging stations; this is in order to establish an environmental baseline for the surface hydrology. Six of the seven gaging stations have been monitoring water flow since March, 1974. Specific conductance and temperature were monitored periodically from March, 1974, to November, 1974, at which time continuous monitoring equipment for specific conductance and temperature was installed in the six stations. The seventh gaging station, located at the mouth of "Rinky Dink" Gulch, has been used to monitor water flow since November, 1974. Automatic sediment samplers have been installed in order to collect data on the sediment load of the stream.

Semi-monthly water samples are collected from the seven gaging stations given in Table 1.2-1 and are analyzed for various chemical constituents. Table 1.2-2 gives the schedule for the collection and analysis for the chemical constituents. The resultant data is discussed in Section 1.2.2 of this report. Figure 1.2-1 shows the locations of the surface water and rain gaging stations.

The USGS has installed six rain gaging stations in addition to the surface gaging stations. Three of these stations are of the storage type gages; precipitation is collected and hand measured at regular intervals. These three stations are associated with the surface gaging stations at Dry Fork, Box Elder and Corral Gulch west of the tract. The remaining three rain gages are of the recording type in that a precipitation rate, for example, inches per hours, can be monitored. One of these stations is located west of the tract near the drainage divide of Cathedral Bluffs. The second station is located at the surface gaging station near the mouth of Yellow Creek. The third is located at the Stake Springs Draw surface gaging station.

TABLE 1.2-1

LOCATION AND USGS IDENTIFICATION NUMBERS FOR SURFACE AND RAIN GAGING STATIONS

USGS Identification number	Location
09306237	Dry Fork near west line Tract C-a
09306235	Corral Gulch near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
09306242	Corral Gulch east of Tract C-a
09306200	Stake Springs Draw near confluence with Corral Gulch
09306255*	Yellow Creek near White River, Colorado
09306241	"Rinky Dink" Gulch near east line Tract C-a
	Rain Storage-Type Gages
09306235	Corral Gulch near west line Tract C-a
09306237	Dry Fork near west line Tract C-a
09306240	Box Elder Gulch near west line Tract C-a
	Recording Rain Gage
09306230	Stake Springs Draw near confluence with Corral Gulch
09306255	Yellow Creek near White River, Colorado
No number	Cathedral Bluffs located in NW-1/4, NW-1/4, Sec. 14, R100W T2S, R100W

* Was given incorrectly in RBOSP Progress Report 2-Summary

TABLE 1.2-2

DATA COLLECTION SCHEDULE FOR STREAM GAGING STATIONS

Continuously or Automatically

- Flow Rate
- Sediment Discharge
- Temperature
- Specific Conductance

Periodically

- Storage Rain Gages
- Recording Rain Gages

Semi-Monthly

Water Samples Analyzed For

- Barium
- Boron
- Calcium
- Chromium (Hexavalent)
- Copper
- Fluoride
- Iron
- Lithium
- Magnesium
- Potassium
- Selenium
- Silica
- Sodium
- Sulfate
- Zinc
- Ammonia
- Bicarbonate
- Carbonate
- Chloride
- Color
- Dissolved Solids
- Kjeldahl Nitrogen
- Nitrate
- Nitrite
- Odor
- Oil and Grease
- Turbidity
- Dissolved Oxygen
- pH
- Arsenic
- Cadmium
- Lead
- Manganese
- Mercury
- Total Phosphate
- Ortho Phosphate
- Cyanide
- Sulfide

Quarterly

Sample and Analyze

- COD
- Fecal Coliform
- Pesticides
- Polycyclic Aromatics
- Radioactivity
  - Gross Alpha
    - 4 Picocuries/l
    - Ra^{226}
  - Gross Beta
    - 100 Picocuries/l
    - Th^{230}
    - Uranium
- Spectrographic Scan
  - 67 Elements
- TOC
  - 10 mg/l
  - DOC
  - SOC
  - Phenols
  - Sulfur
  - Nitrogen

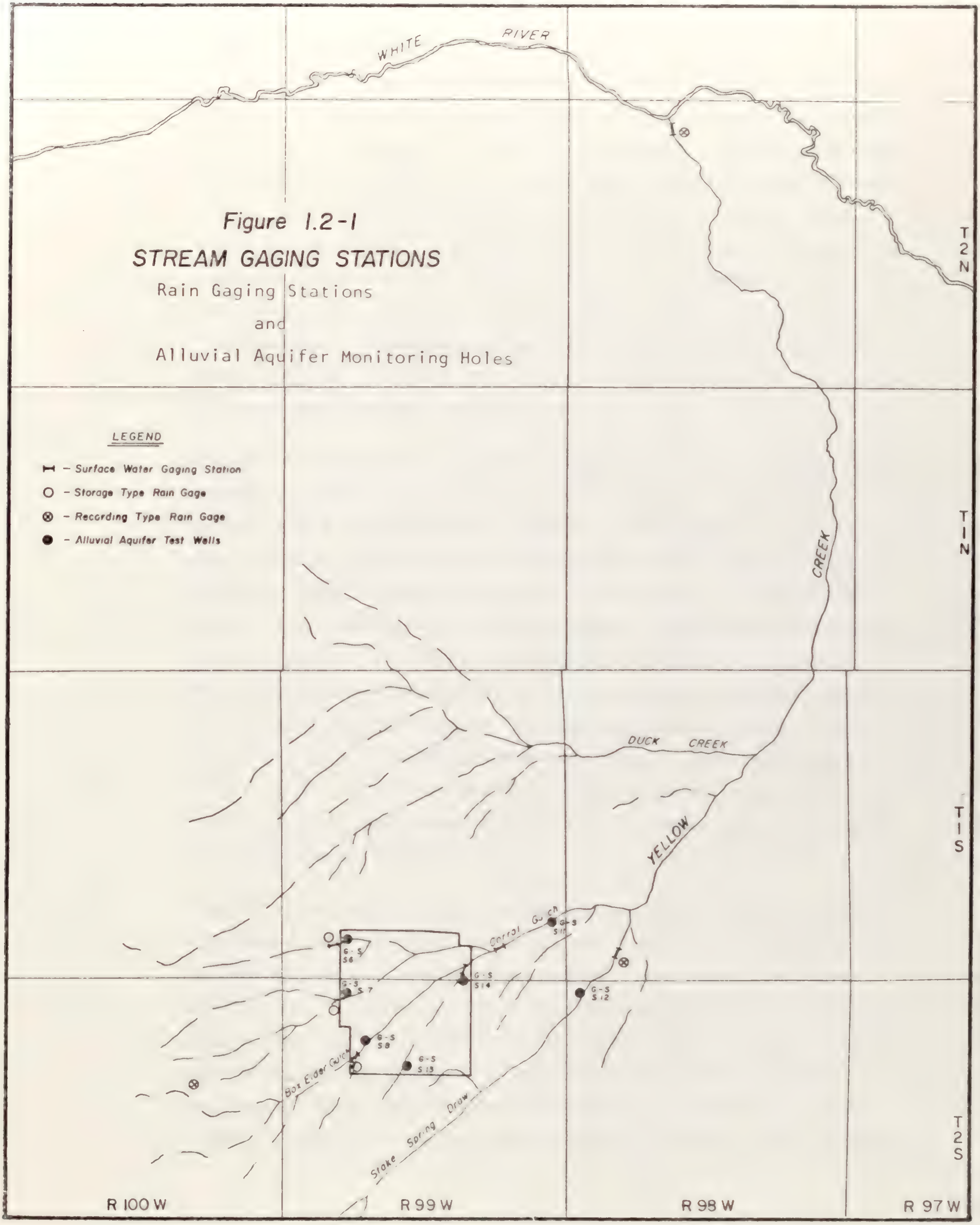


Figure 1.2-1
STREAM GAGING STATIONS
Rain Gaging Stations
and
Alluvial Aquifer Monitoring Holes

1.2.2 SURFACE WATER DATA COLLECTION

The first water data were collected on March 14, 1974, consisting of water flow records. Conductivity and temperature have been monitored from November, 1974, to the present. Table 1.2-2 shows the sampling intervals and types of data being collected for each of the seven surface water gaging stations. In Volume I, Raw Data, Section 1.2.2 is the USGS computer printout for the various chemical constituents analyzed by the USGS laboratories in Salt Lake City, Utah. Figures 1.2-2 through 1.2-4 are plots of the instantaneous discharge and specific conductants reported from these computer printouts and Figures 1.2-5 through 1.2-7 are plots of boron and fluoride concentration.

The data received from the USGS on the three recording-type precipitation gaging stations are given in Volume I, Raw Data, Section 1.2.2 and plotted on Figures 1.2-8 through 1.2-10. To date, no data have been received from the USGS on the storage-type rain gages. When information is available, it will be included in the appropriate progress report. The provisional data sheets supplied to us on the continuous monitoring of surface flow, temperature and conductivity do not agree with the instantaneous surface flow data on the USGS computer printout; therefore, no graphs or analyses have been made on this continuous data. At such time when the USGS provides us with the final copies of their continuous data, it will be reported in the appropriate quarterly report.

Precipitation records from January through May, 1975, indicate widespread peak moisture falls over the tract. Some correlation between gaging stations in late January, late March, and early and late May is possible, which indicates widespread moisture fall during these periods. Corresponding peak amounts between stations vary however, indicating local amounts differ substantially. Instantaneous peak amounts occurred in May and ranged up to .84 inches. Cumulative precipitation appears to reach a peak in March,

though instantaneous peak amounts generally increase steadily through late April. Precipitation becomes either a recharge source for alluvial and deep aquifer systems, surface runoff, or it evaporates. Since a major portion of precipitation from January through May was snowfall, a large portion was evaporated or sublimated. Figures 1.2-8 through 1.2-10 show precipitation data available to date.

Of the seven surface water gaging stations, only three have reported discharge in 1975. These include Corral Gulch below Water Gulch near the west boundary of Tract C-a, Corral Gulch just east of the tract, and Yellow Creek near the confluence with the White River. The other monitored streams are intermittent in that they only flow during spring snowmelt and runoff during heavy rains. The discharge in Corral Gulch on the western tract boundary presently is influenced by spring snowmelt runoff. Corral Gulch also receives water where the streambed gradient is close to the water table. A spring in Section 5 that is tributary to Corral Gulch appears to flow year around. These flows are intermittent downstream due to changes in the volume of artesian flow and variation in the water table level. Both Corral Gulch east of the tract and Yellow Creek flow throughout the year.

Box Elder Gulch has intermittent flow due to fluctuations in water table level. The source of flow for this gulch is runoff, or when the water table is high enough to intercept the streambed gradient. Figures 1.2-2 through 1.2-4 show plots of data to date. A review of the data from the Corral Gulch surface gaging station indicates a peak flow of about 3 cfs occurring in May, 1975. Yellow Creek near the White River had a peak discharge in March, 1974, as well as May, 1974, and in 1975 a peak discharge appears to occur in early March. These highs appear to correlate with high precipitation values recorded in the area. Box Elder Stream Gaging Station also recorded a peak flow during May of 1974. Flow has not been

recorded since mid-June, 1974, in Box Elder Gulch. Other peak values in early spring can be attributed to high snowmelt rates. During the summer months, frequent isolated flow peaks occur that cannot be correlated from one station to another. This is due to the local thunder-shower nature of summer precipitation.

Conductivity has remained relatively stable at 1100 umhos/cm in Corral Gulch, with low values occurring during peak runoff times. A peak value of about 1750 umhos/cm occurs in April, 1975, which coincides with initiation of G-S D19 pumping and discharge into Corral Gulch. In Yellow Creek near the White River, conductivity fluctuates around 3500 umhos/cm, with low values of about 2100 umhos/cm occurring during peak runoff points, and a high of 4500 umhos/cm during April. Figures 1.2-2 through 1.2-4 show conductivity values for the stream gaging stations.

Tables 1.2-3 through 1.2-5 show water quality analysis for the reporting period from the stream gaging stations.

TABLE 1.2-3
SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306235
CORRAL GULCH NEAR WEST LINE TRACT C-a

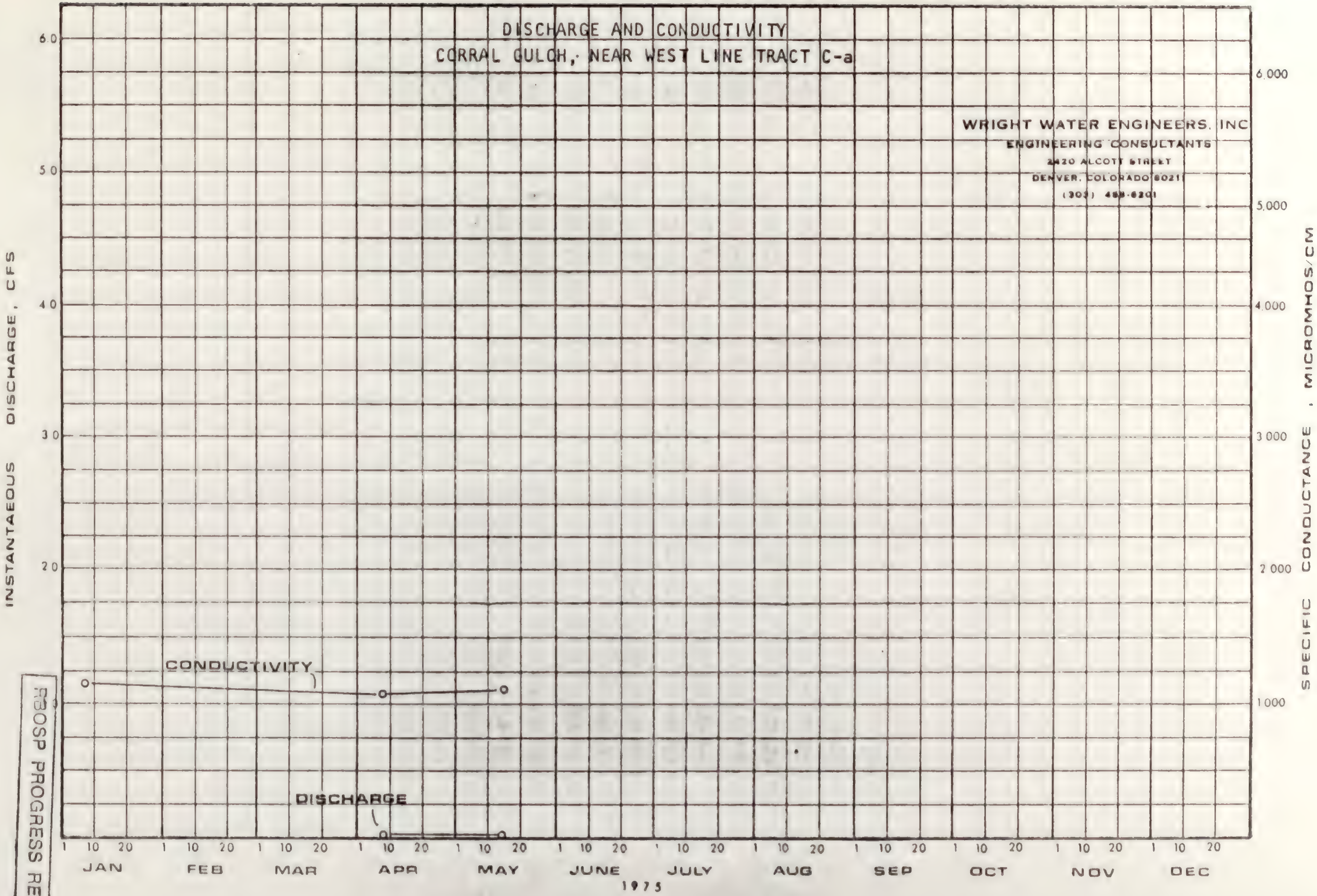
	3/27/75	3/16/75	4/8/75 1400	5/14/75 1045								
1. Alkalinity (mg/l)			324	231								
2. Aluminum (ug/l)			---	---								
3. Ammonia (mg/l)			.12	.04								
4. Aromatics, Polycyclic			---	---								
5. Arsenic (ug/l)			4	4								
6. Barium (ug/l)			100	100								
7. Beryllium (ug/l)			---	---								
8. Bicarbonate (mg/l)			395	355								
9. Bismuth (ug/l)			---	---								
10. Boron (ug/l)			90	90								
11. Cadmium (ug/l)			0	0								
12. Carbonate (mg/l)			0	0								
13. Carbon Dioxide (mg/l)			2.0	11								
14. Chloride (mg/l)			7.8	8.9								
15. Chromium (ug/l)			0	0								
16. Cobalt (ug/l)												
17. COD												
18. Coliform, Total & Fecal												
19. Color (PVC)			9	10								
20. Conductivity, Specific			1020	1100								
21. Copper (ug/l)			8	2								
22. Cyanide (mg/l)			100	.01								
23. Discharge (CFS)												
24. Discharge, Instantaneous			.04	.02								
25. Dissolved Oxygen (mg/l)			---	8.7								
26. Fluoride (mg/l)			.2	.2								
27. Gallium (ug/l)												
28. Germanium (ug/l)												
29. Hardness (Ca, Mg) (mg/l)			460	420								
30. Hardness, Non-Carbonate (mg/l)			140	130								
31. Iron (ug/l)			50	20								
32. Kjeldahl Nitrogen (mg/l)			4.2	.30								
33. Lead (ug/l)			0	1								
34. Lithium (ug/l)			20	20								
35. Magnesium (mg/l)			60	56								
36. Manganese (ug/l)			0	0								
37. Mercury (ug/l)			1.0	.00								
38. Molybdenum (ug/l)			---	---								
39. Nickel (ug/l)			---	---								
40. Nitrate (mg/l)			4.3	2.2								
41. Nitrite (mg/l)			.00	.00								
42. Nitrite Plus Nitrate (mg/l)			.98	.50								
43. Nitrogen, Ammonia			.09	.03								
44. Odor (Severity)			1	0								
45. Oil & Grease (mg/l)			3	0								
46. Ortho-Phosphate (mg/l)			.06	.06								
47. Ortho-Phosphorus (mg/l)			.02	.02								
48. Pesticides												
49. pH			8.5	7.7								
50. Phosphorus, Total (mg/l)			1.3	.03								
51. Potassium (mg/l)			1.6	1.5								
52. Selenium (ug/l)			4	4								
53. Silica (mg/l)			19	18								
54. Silver (ug/l)			---									
55. Sodium (mg/l)			86	91								
56. Sodium Adsorption Ratio			1.7	1.9								
57. Sodium (%)			29	32								
58. Solids, Dissolved (mg/l)			729	719								
59. Solids, Dissolved T/D			.08	.04								
60. Solids, Dissolved T/Ac-Ft			.99	.98								
61. Solids, Suspended												
62. Strontium (ug/l)			---	---								
63. Sulfate (mg/l)			2.70	290								
64. Sulfide (mg/l)			.2	.0								
65. Temperature (°C)			2.0	20.0								
66. Tin (ug/l)			---	---								
67. Titanium (ug/l)			---	---								
68. Turbidity (JTU)			420	18								
69. Vanadium (ug/l)			---	---								
70. Zinc (ug/l)			20	10								
71. Zirconium (ug/l)			---	---								
72. Calcium (mg/l)			85	75								
73. Complete Element Span												
74. Radioactivity												
Gross Alpha (pci)												
Radium 226*												
Gross Beta												
Thorium 230**												
Uranium**												
75. Total Organic Carbon (mg/l)			---	---								
If TOC >10 mg/liter, then												
Nitrogen (Base Extraction)												
Organic Carbon, Dissolved												
Organic Carbon, Suspended												
Phenols												
Sulfur (Acid Extraction)												
76. Ortho-Phosphorous			.45	.04								
77. Phosphate			---	.09								

TABLE 1.2-4
SUMMARY WATER ANALYSIS
STREAM GAGING STATION, USGS 09306242
CORRAL GULCH EAST OF TRACT

Date	[illegible]/12/75	3/[illegible]/75	4/[illegible]/75	4/[illegible]/75	[illegible]/23/75	5/14/75	5/[illegible]/75					
Time	1100	1[illegible]	10[illegible]	1100	1100	1335	1[illegible]					
1. Alkalinity (mg/l)	417	---	---	[illegible]	[illegible]	421	662					
2. Aluminum (ug/l)	20	---	---	---	---	---	---					
3. Ammonia (mg/l)	.28	---	---	.35	.15	.03	.22					
4. Aromatics, Polycyclic												
5. Arsenic (ug/l)	6	---	---	7	2	5	9					
6. Barium (ug/l)	50	---	---	100	[illegible]	0	100					
7. Beryllium (ug/l)	<2	---	---	---	---	---	---					
8. Bicarbonate (mg/l)	508	---	---	[illegible]	335	513	815					
9. Bismuth (ug/l)	<5	---	---	---	---	---	---					
10. Boron (ug/l)	100	---	---	320	350	460	670					
11. Cadmium (ug/l)	<60	---	---	0	1	1	0					
12. Carbonate (mg/l)	0	---	---	0	0	0	0					
13. Carbon Dioxide (mg/l)	13	---	---	7.2	[illegible]	65	13					
14. Chloride (mg/l)	8.9	---	---	11	16	11	15					
15. Chromium (ug/l)	<5	---	---	0	0	0	0					
16. Cobalt (ug/l)	<5	---	---	---	---	---	---					
17. COD	94	---	---	---	---	---	---					
18. Coliform, Total & Fecal												
19. Color (PVC)	3	---	---	5	0	5	6					
20. Conductivity, Specific	1200	---	---	1725	1550	1300	1550					
21 Copper (ug/l)	2	---	---	3	6	1	1					
22. Cyanide (mg/l)	.00	---	---	.00	.01	.01	.02					
23. Discharge (CFS)												
24. Discharge, Instantaneous	.34	---	---	1.1	1.3	.46	3.1					
25. Dissolved Oxygen (mg/l)	9.0	---	5.4	5.4	7.3	8.0	8.1					
26. Fluoride (mg/l)	.4	---	---	10	4.3	.4	2.8					
27. Gallium (ug/l)	<2	---	---	---	---	---	---					
28. Germanium (ug/l)	<6	---	---	---	---	---	---					
29. Hardness (Ca, Mg) (mg/l)	520	---	---	360	3[illegible]	430	390					
30. Hardness, Non-Carbonate (mg/l)	98	---	---	0	0	58	0					
31. Iron (ug/l)	120	---	---	30	10	30	30					
32. Kjeldahl Nitrogen (mg/l)	.67	---	---	2.4	1.1	.14	2.2					
33. Lead (ug/l)	<6	---	---	2	8	1	1					
34. Lithium (ug/l)	14	---	---	30	25	10	20					
35. Magnesium (mg/l)	70	---	---	52	59	63	53					
36. Manganese (ug/l)	43	---	---	0	20	20	6					
37. Mercury (ug/l)	.0	---	---	.3	0	0	0					
38. Molybdenum (ug/l)	30	---	---	---	---	---	---					
39. Nickel (ug/l)	<4	---	---	---	---	---	---					
40. Nitrate (mg/l)	1.2	---	---	1.2	1.5	1.4	3.0					
41. Nitrite (mg/l)	.07	---	---	.00	.10	.00	.03					
42. Nitrite Plus Nitrate (mg/l)	.28	---	---	.28	.35	.32	.68					
43. Nitrogen, Ammonia	.22	---	---	.27	.12	.02	.17					
44. Odor (Severity)	3	2	2	---	0	0	1					
45. Oil & Grease (mg/l)	4	---	---	2	3	0	2					
46. Ortho-Phosphate (mg/l)	.28	---	---	.06	.12	.15	.12					
47. Ortho-Phosphorus (mg/l)	.09	---	---	.02	[illegible]	.05	.04					
48. Pesticides												
49. pH	7.8	---	---	8.3	8.2	7.1	8.0					
50. Phosphorus, Total (mg/l)	.37	---	---	.60	.58	.05	.41					
51. Potassium (mg/l)	1.4	---	---	2.3	2.0	1.8	2.2					
52. Selenium (ug/l)	2	---	---	2	1	2	2					
53. Silica (mg/l)	13	---	---	19	19	21	20					
54. Silver (ug/l)	0	---	---	---	---	---	---					
55. Sodium (mg/l)	110	---	---	300	240	120	250					
56. Sodium Adsorption Ratio	2.1	---	---	6.8	5.4	2.4	5.5					
57. Sodium (%)	32	---	---	64	58	35	58					
58. Solids, Dissolved (mg/l)	838	---	---	1140	1040	850	1020					
59. Solids, Dissolved T/D	.77	---	---	3.57	3.23	1.06	8.54					
60. Solids, Dissolved T/Ac-Ft	1.14	---	---	1.55	1.41	1.16	1.39					
61. Solids, Suspended												
62. Strontium (ug/l)	1600	---	---	---	---	---	---					
63. Sulfate (mg/l)	290	---	---	240	[illegible]	[illegible]	200					
64. Sulfide (mg/l)	.0	---	---	.3	.0	.2	.2					
65. Temperature (°C)	8.0	---	---	[illegible]	13.0	14.0	11.0					
66. Tin (ug/l)	<5	---	---	---	---	---	---					
67. Titanium (ug/l)	<4	---	---	---	---	---	---					
68. Turbidity (JTU)	100	---	---	250	[illegible]	1	120					
69. Vanadium (ug/l)	3.0	---	---	---	---	---	---					
70. Zinc (ug/l)	0	---	---	30	10	6	10					
71. Zirconium (ug/l)	<9	---	---	---	---	---	---					
72. Calcium (mg/l)	90	---	---	60	[illegible]	88	68					
73. Complete Element Span												
74. Radioactivity												
Gross Alpha (pci)	<10	---	---	---	---	---	---					
Radium 226*												
Gross Beta	<2.4	---	---	---	---	---	---					
Thorium 230**												
Uranium**												
75. Total Organic Carbon (mg/l)	9.8	---	---	---	---	---	---					
If TOC >10 mg/liter, then												
Nitrogen (Base Extraction)												
Organic Carbon, Dissolved												
Organic Carbon, Suspended												
Phenols												
Sulfur (Acid Extraction)												
76. Total Ortho-Phosphorus	.11	---	---	.59	.05	.06	.04					
77. Phosphate	---	---	---	---	[illegible]	.15	1.3					

TABLE 1.2-5
SUMMARY WATER ANALYSES
STREAM GAGING STATION, USGS 09306255
YELLOW CREEK NEAR WHITE RIVER

Date	3/12/75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
Time	[illegible]	1000	[illegible]	[illegible]	[illegible]	[illegible]						
1. Alkalinity (mg/l)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
2. Aluminum (ug/l)	150	---	---	---	---	---						
3. Ammonia (mg/l)	.00	.22	.24	.30	[illegible]	.02						
4. Aromatics, Polycyclic												
5. Arsenic (ug/l)	5	3	1	5	[illegible]	5						
6. Barium (ug/l)	200	100	<100	[illegible]	[illegible]	300						
7. Beryllium (ug/l)	<4	---	---	---	---	---						
8. Bicarbonate (mg/l)	1620	1210	1480	930	1440	1510						
9. Bismuth (ug/l)	<15	---	---	---	---	---						
10. Boron (ug/l)	560	630	680	[illegible]	530	640						
11. Cadmium (ug/l)	<170	0	0	0	1	2						
12. Carbonate (mg/l)	0	203	97	0	1	27						
13. Carbon Dioxide (mg/l)	10	5.2	4.3	[illegible]	3.8	5.4						
14. Chloride (mg/l)	130	110	130	130	[illegible]	120						
15. Chromium (ug/l)	<15	0	0	0	0	0						
16. Cobalt (ug/l)	<15	---	---	---	---	---						
17. COD	7	---	---	---	---	---						
18. Coliform, Total & Fecal												
19. Color (PVC)	3	10	3	2	4	3						
20. Conductivity, Specific	3500	3500	3250	3400	3500	3000						
21. Copper (ug/l)	5	0	3	1	7	3						
22. Cyanide (mg/l)	.00	.00	---	.00	.00	.00						
23. Discharge (CFS)	---	---	---	---	---	---						
24. Discharge, Instantaneous	2.9	2.2	1.2	3.3	[illegible]	1.7						
25. Dissolved Oxygen (mg/l)	8.5	10.6	10.4	9.1	9.6	7.6						
26. Fluoride (mg/l)	2.0	1.9	1.2	1.6	2.1	2.1						
27. Gallium (ug/l)	<5	---	---	---	---	---						
28. Germanium (ug/l)	<20	---	---	---	---	---						
29. Hardness (Ca, Mg) (mg/l)	550	650	500	590	550	570						
30. Hardness, Non-Carbonate (mg/l)	0	0	0	0	0	0						
31. Iron (ug/l)	65	20	10	10	30	40						
32. Kjeldahl Nitrogen (mg/l)	.17	.71	---	2.6	.60	.30						
33. Lead (ug/l)	<16	0	0	0	9	4						
34. Lithium (ug/l)	160	120	120	140	130	170						
35. Magnesium (mg/l)	110	130	98	120	130	120						
36. Manganese (ug/l)	14	20	10	10	30	10						
37. Mercury (ug/l)	.0	.0	.3	.0	.0	.2						
38. Molybdenum (ug/l)	30	---	---	---	--	---						
39. Nickel (ug/l)	<10	---	---	---	---	---						
40. Nitrate (mg/l)	[illegible]	6.6	9.7	7.9	4.4	2.5						
41. Nitrite (mg/l)	.00	.03	.03	.03	.03	.03						
42. Nitrite Plus Nitrate (mg/l)	2.1	1.5	2.2	[illegible]	1.0	.58						
43. Nitrogen, Ammonia	.00	.17	.19	.23	.00	.06						
44. Odor (Severity)	2	2	---	---	0	0						
45. Oil & Grease (mg/l)	3	3	---	2	2	1						
46. Ortho-Phosphate (mg/l)	.15	.37	.34	.15	.12	.06						
47. Ortho-Phosphorus (mg/l)	.05	.12	.11	.05	.04	.02						
48. Pesticides												
49. pH	8.4	8.7	8.8	8.7	8.8	8.7						
50. Phosphorus, Total (mg/l)	.02	.13	---	.79	.09	.04						
51. Potassium (mg/l)	4.6	3.5	3.8	4.4	7.4	3.9						
52. Selenium (ug/l)	3	2	3	3	1	1						
53. Silica (mg/l)	20	14	14	14	11	7.1						
54. Silver (ug/l)	<2	---	---	---	---	---						
55. Sodium (mg/l)	710	700	680	840	710	740						
56. Sodium Adsorption Ratio	13	12	13	15	13	13						
57. Sodium ( )	74	70	75	75	73	74						
58. Solids, Dissolved (mg/l)	2320	2450	[illegible]	2740	2330	2430						
59. Solids, Dissolved T/D	18.6	14.6	7.66	25.0	[illegible]	11.2						
60. Solids, Dissolved T/Ac-Ft	3.16	3.33	3.09	3.73	3.17	3.30						
61. Solids, Suspended												
62. Strontium (ug/l)	3500	---	---	---								
63. Sulfate (mg/l)	490	640	470	630	600	570						
64. Sulfide (mg/l)	.0	.1	.3	.2	.1	.1						
65. Temperature (°C)	9.0	3.5	6.0	9.0	9.0	17.0						
66. Tin (ug/l)	<15	---	---	---	---	---						
67. Titanium (ug/l)	[illegible]	---	---	---	---	---						
68. Turbidity (JTU)	3	[illegible]	3	[illegible]	[illegible]	18						
69. Vanadium (ug/l)	[illegible]	---	---	---	---	---						
70. Zinc (ug/l)	6	[illegible]	6	[illegible]	0	6						
71. Zirconium (ug/l)	<25	---	---	---	---	---						
72. Calcium (mg/l)	37	[illegible]	37	[illegible]	[illegible]	[illegible]						
73. Complete Element Span												
74. Radioactivity												
Gross Alpha (pci)	<36	---	--	---	---	---						
Radium 226*												
Gross Beta	8.8	---	---	---	---	---						
Thorium 230**												
Uranium**												
75. Total Organic Carbon (mg/l)	4.7	---	---	---	---	---						
If TOC >10 mg/liter, then												
Nitrogen (Base Extraction)												
Organic Carbon, Dissolved												
Organic Carbon, Suspended												
Phenols												
Sulfur (Acid Extraction)												
76. Total Ortho-Phosphorous (mg/l)	.06	.12	.30	.42	.01	.01						
77. Phosphate	---	---	---	---	23	12						
78. Phosphorus, Dissolved	---	---	---	---	---	---						


DISCHARGE AND CONDUCTIVITY
CORRAL GULCH, NEAR WEST LINE TRACT C-a

RBOSP PROGRESS REPORT

Figure 1.2-2

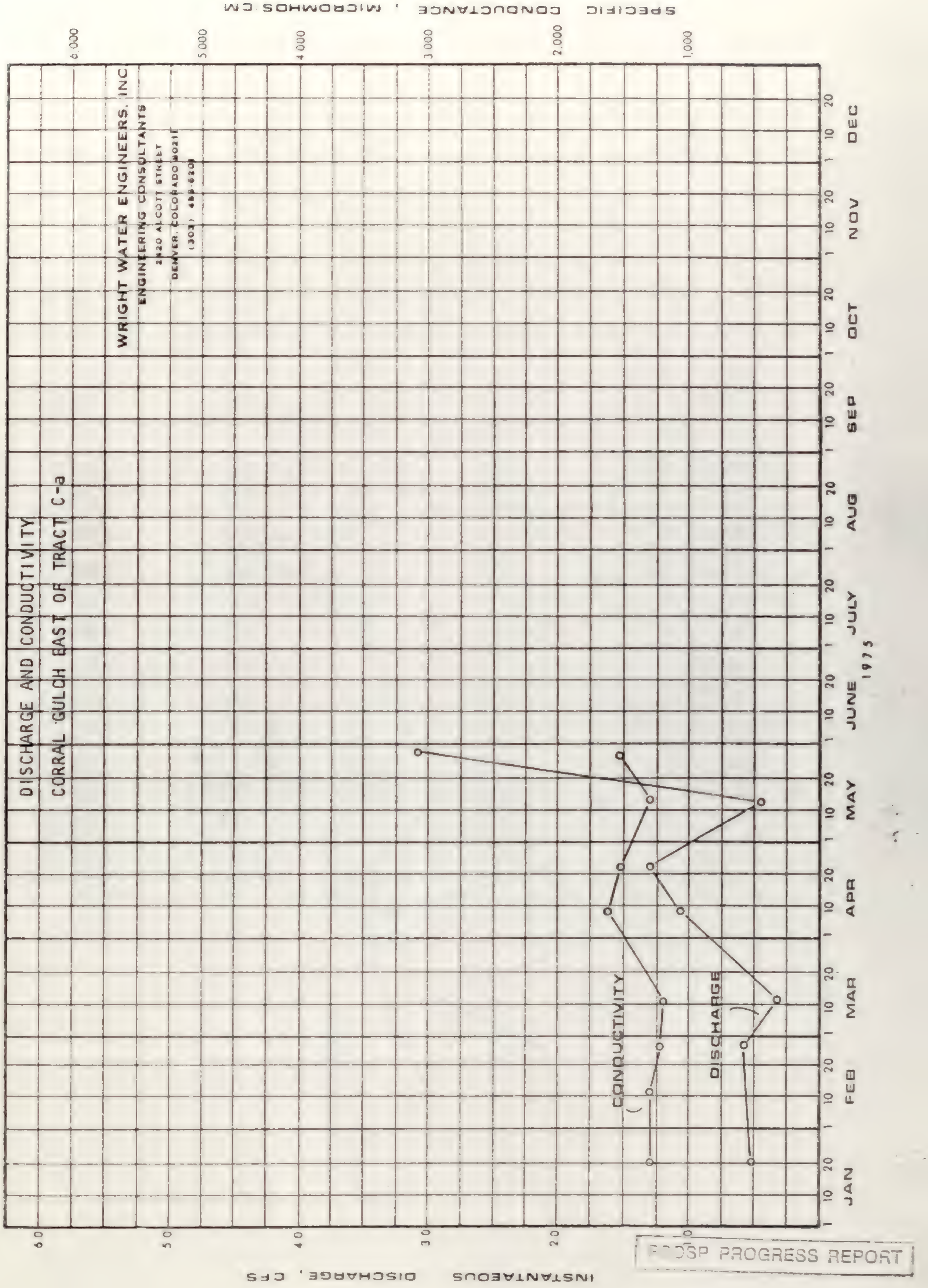
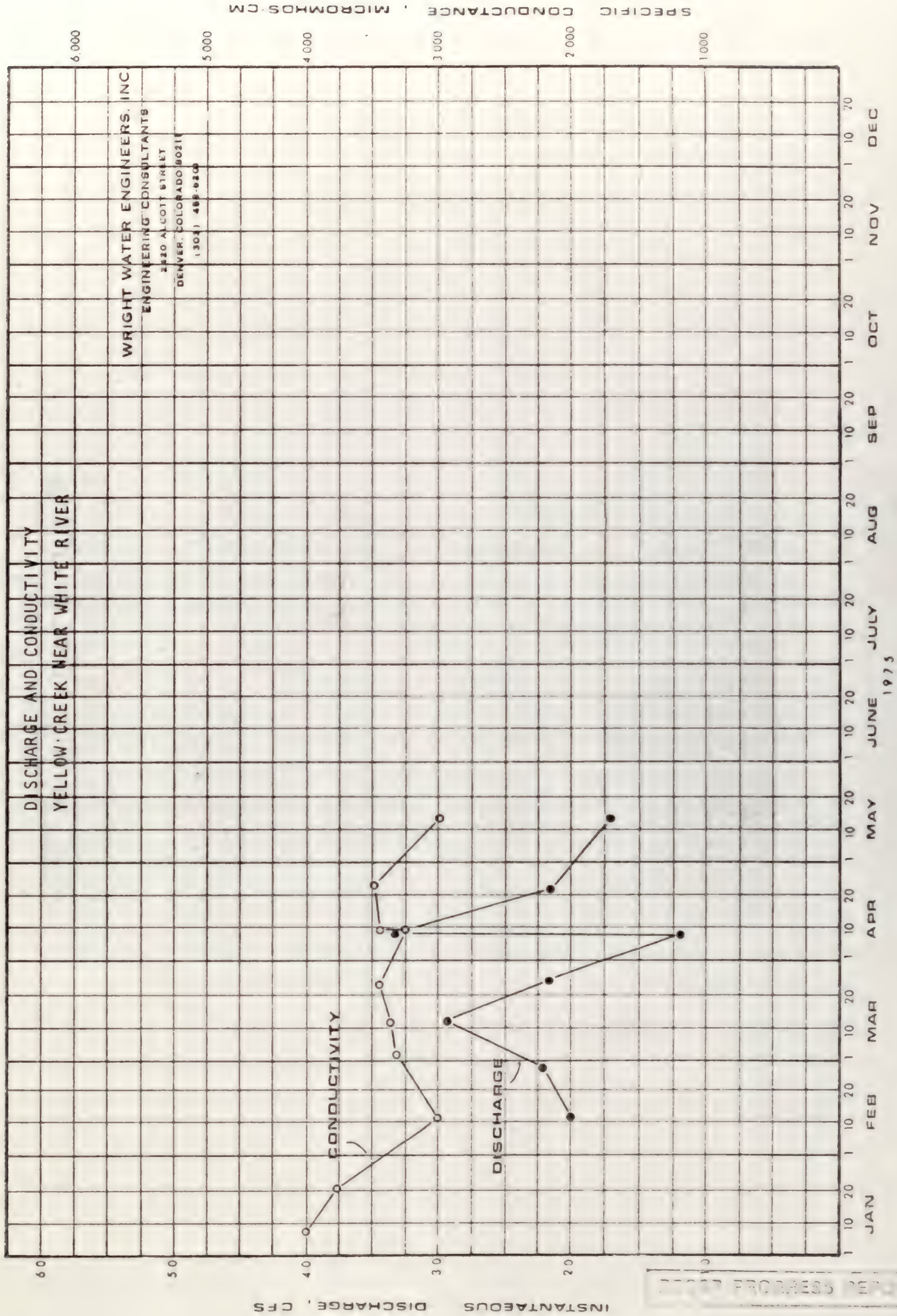
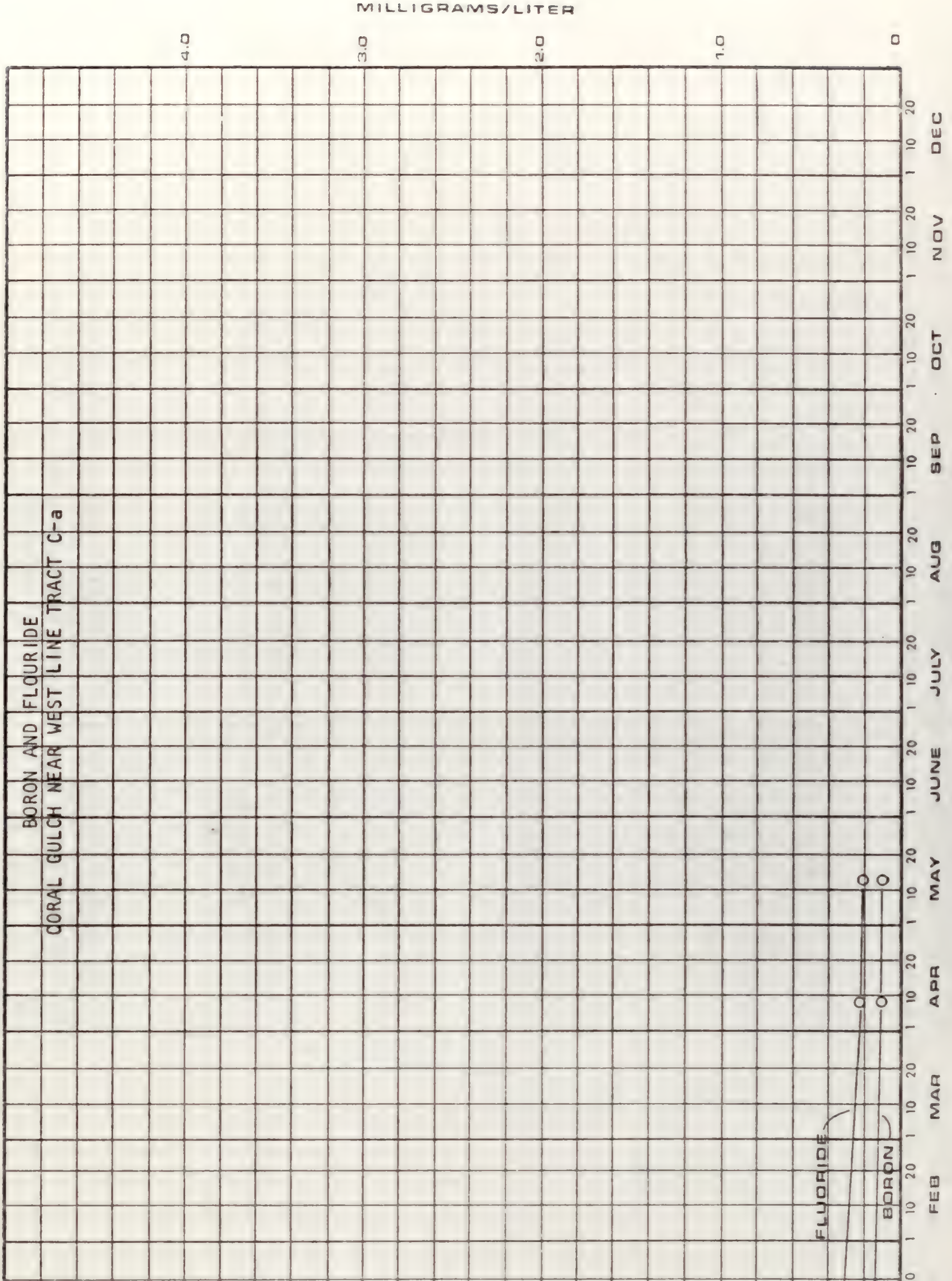

DISCHARGE AND CONDUCTIVITY
CORRAL GULCH EAST OF TRACT C-a
WRIGHT WATER ENGINEERS, INC
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211
(303) 480-620
SPECIFIC CONDUCTANCE, MICROMHOS/CM
6,000
5,000
4,000
3,000
2,000
1,000
INSTANTANEOUS DISCHARGE, CFS
6.0
5.0
4.0
3.0
2.0
1.0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
1
10
20
1975
CONDUCTIVITY
DISCHARGE

Figure 1.2-3



DRAFT PROGRESS REPORT

Figure 1.2-4



OSP PROGRESS REPORT

Figure 1.2-5

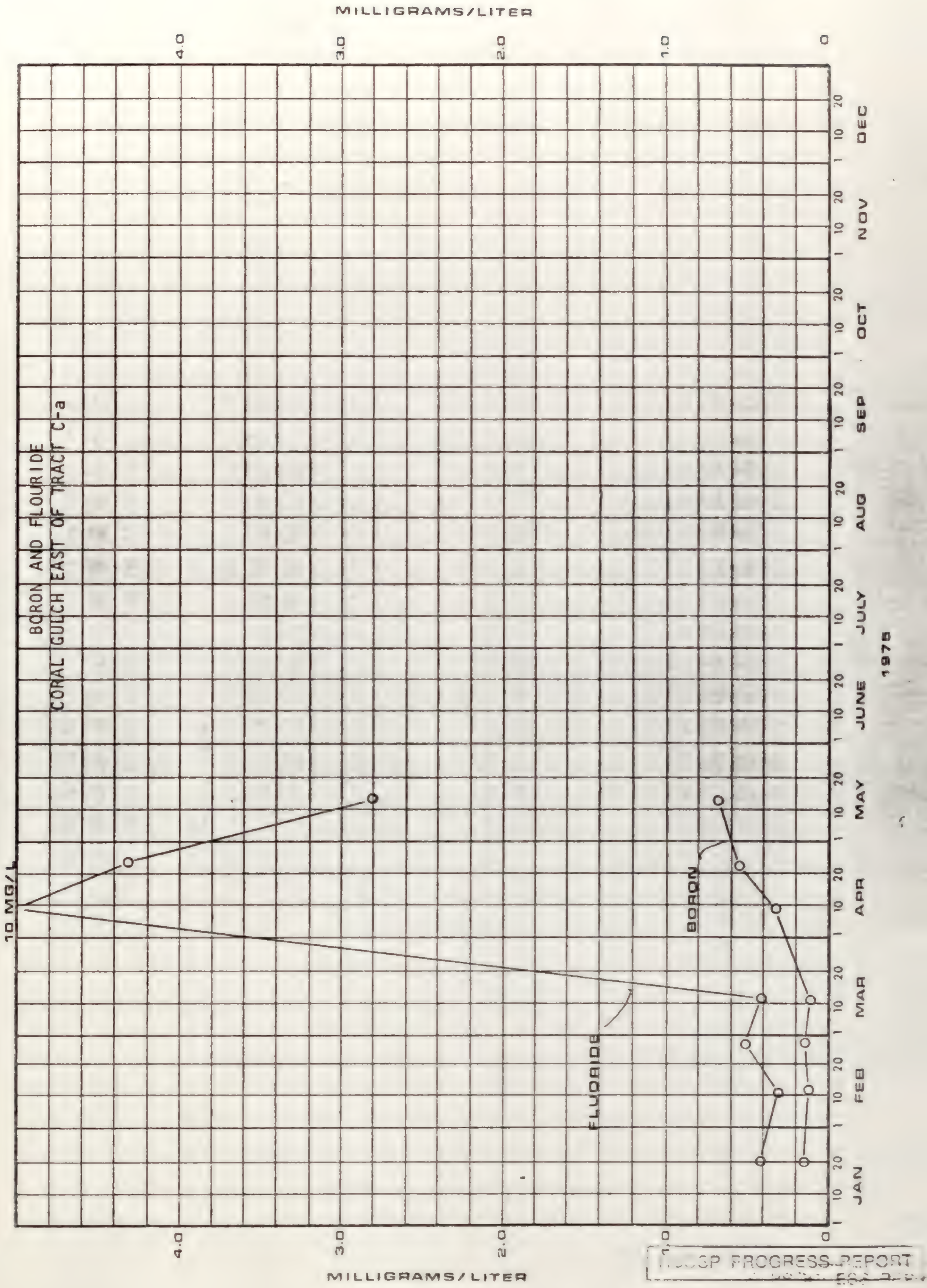
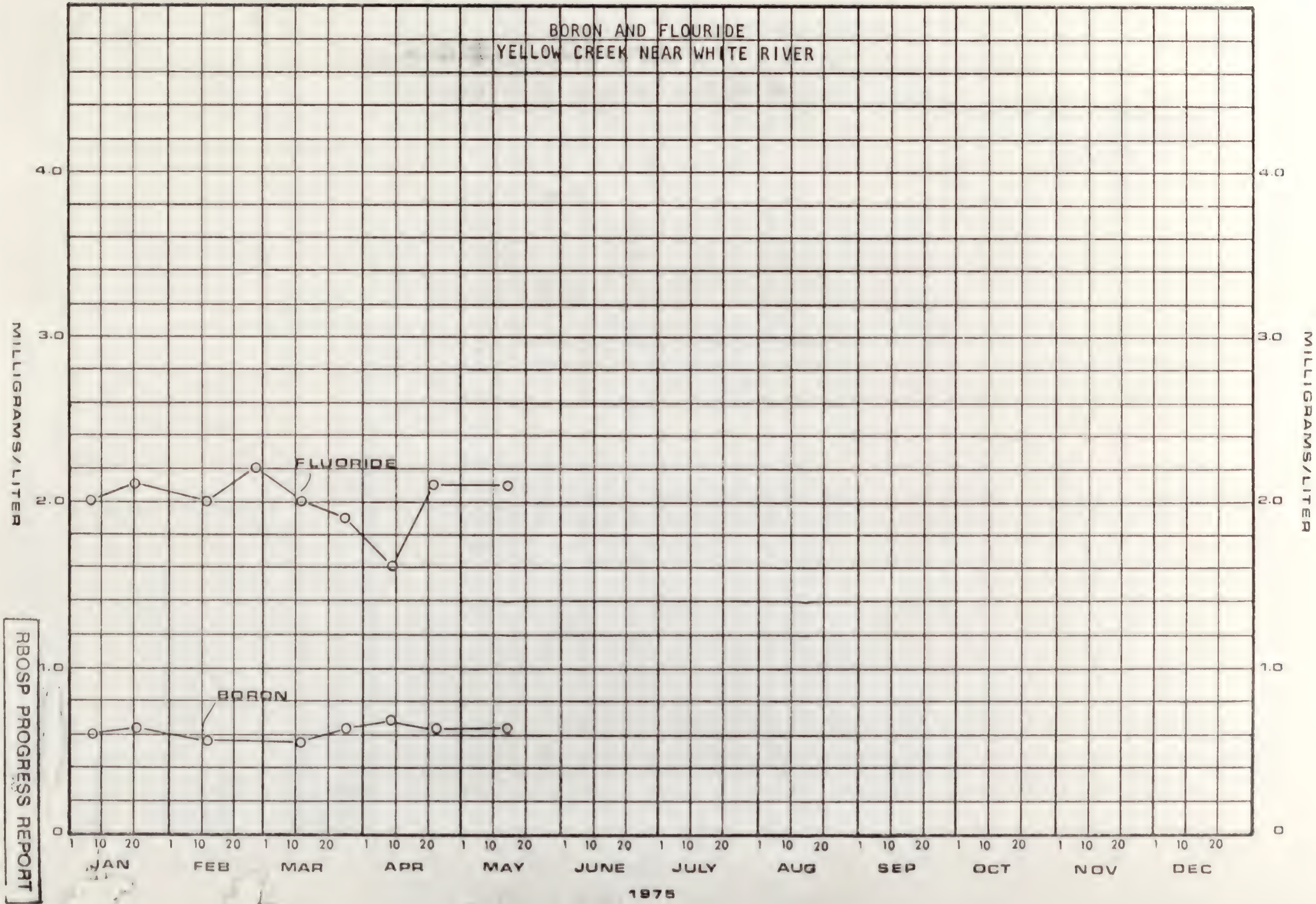
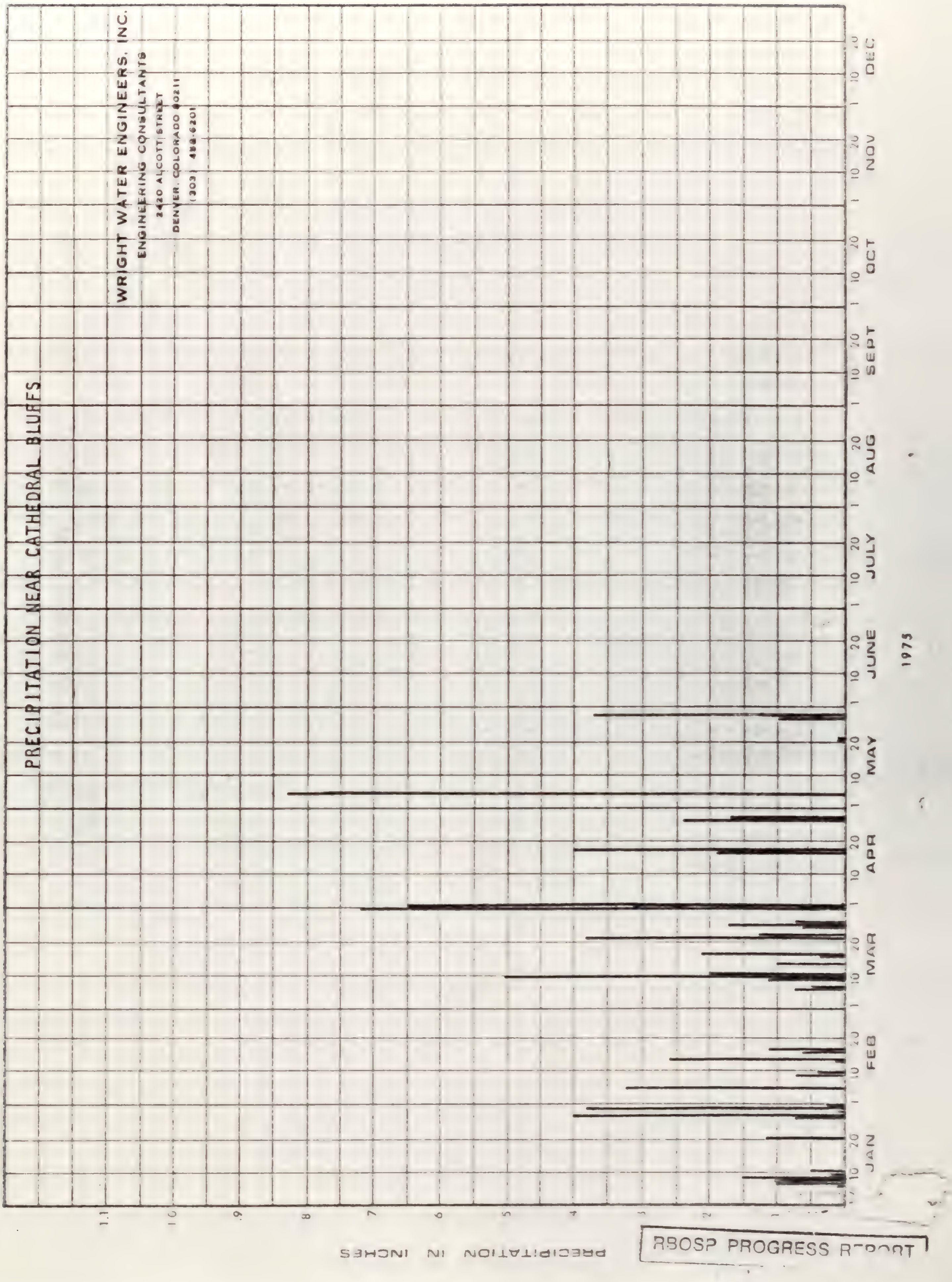

BORON AND FLOURIDE
CORAL GULCH EAST OF TRACT C-a
MILLIGRAMS/LITER
4.0
3.0
2.0
1.0
0
10 MG/L
BORON
FLUORIDE
1
10
20
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
1975

Figure 1.2-6

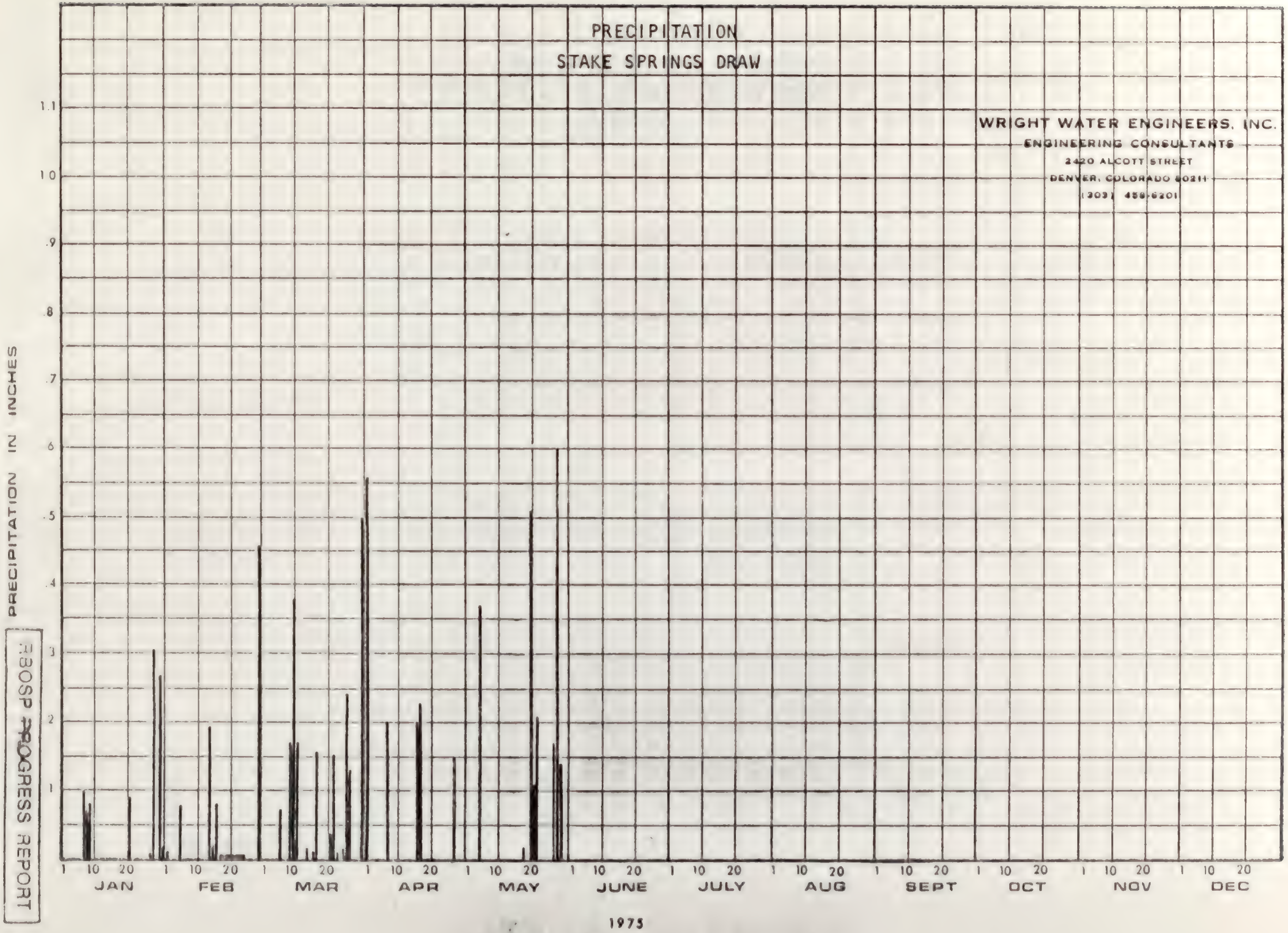


BORON AND FLOURIDE
YELLOW CREEK NEAR WHITE RIVER



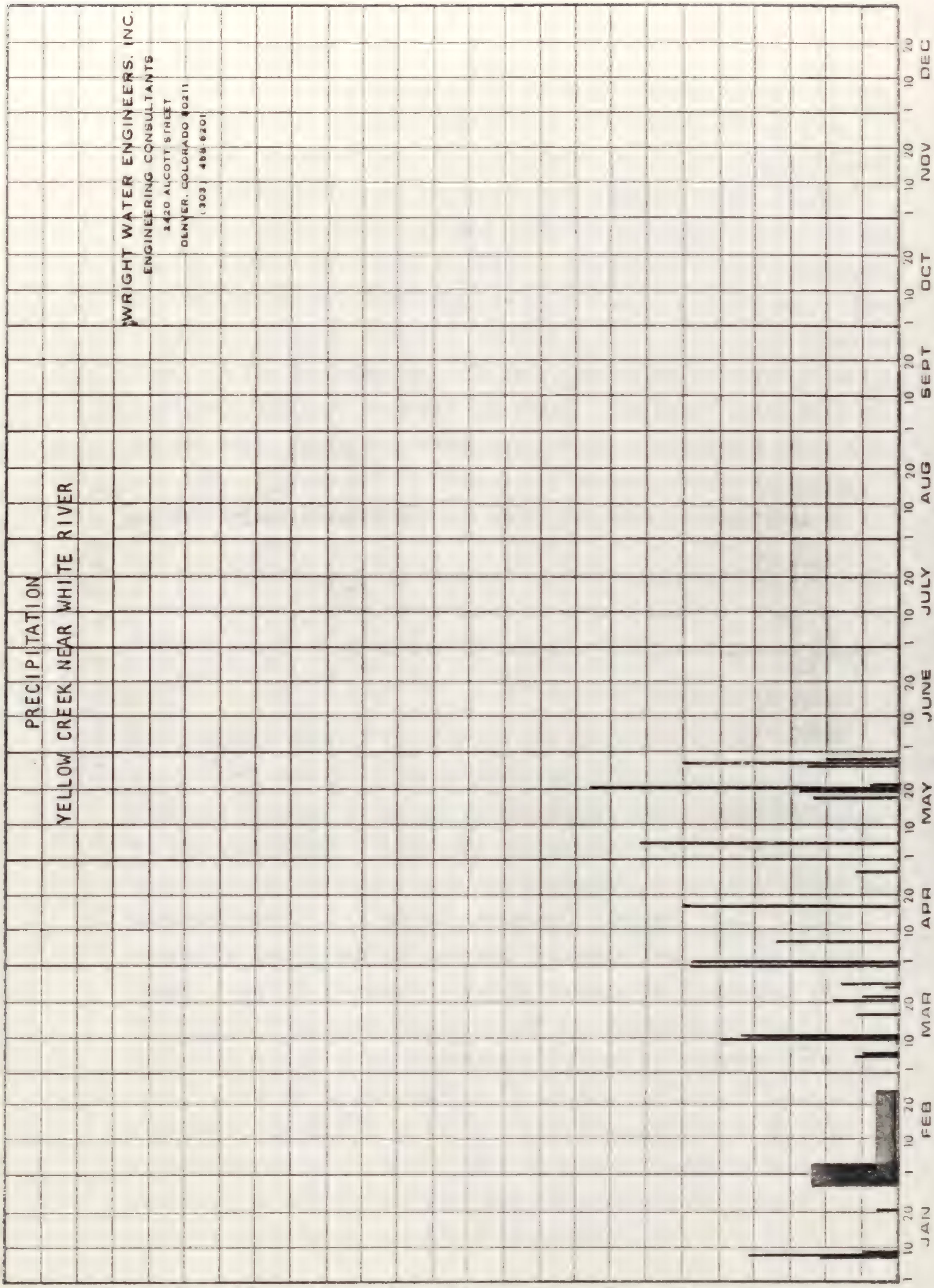
RBOSP PROGRESS REPORT

Figure 1.2-8



RBOSP PROGRESS REPORT

Figure I.2-9



RBOSP PROGRESS REPORT

Figure 1.2-10

1.2.3 ALLUVIAL AQUIFERS

A variable thickness of alluvial material occurs in most of the valley bottoms. Depths ranging from 0 to 140 feet have been measured. Seven alluvial monitor holes have been completed and are reported in Cameron Engineers Inc. report titled, "Summary and Basic Data, Shallow Ground Water Program, Seven Alluvial Test Wells, Federal Oil Shale Tract C-a, Rio Blanco County, Colorado, for Rio Blanco Oil Shale Project Gulf-Standard (Indiana)." (See Appendix, Progress Report 2, Section 1.2.) These seven holes are shown on the attached map. To date, only four of these alluvial monitor holes have recorded any water. The other three have remained dry. These four holes are G-S S7, G-S S8, G-S S-11, and G-S S12. Figures 1.2-11 through 1.2-18 show the water levels, conductivity, temperature and pH of the water versus time.

The first water quality samples for these four shallow alluvial monitor holes, which contain water, were collected in March, 1975. Table 1.2-6 is a water quality summary. The analyses of these samples are shown in Volume I, Raw Data, Section 1.2.3.

Wet chemical results for G-S S7, G-S S8, G-S S11, and G-S S12 cover April and May. The spectrographic analyses were not received in time for this Progress Report and will be included in the next report. Long-term evaluations are not possible as yet; however, certain trends are apparent. Generally, water temperature during this period increases, possibly due to runoff caused by spring ambient warming. Conductivity is stable and ranges from 850 umhos/cm in G-S S8 to near 2000 umhos/cm in G-S S11. Hydrogen ion concentration has ranged from about 6.0 to 6.8, with a high value generally occurring in mid-May, 1975, and lower values being recorded in latter May and June. Temperatures fluctuate from 7.9° C to 14° C., with a general warming trend evident beginning in April. G-S S7 does not exhibit as great a variation as G-S S8, G-S S11, and G-S S12, and has ranged from 8.5°C in late March to 9.8°C in mid-June.

TABLE 1.2-6

SUMMARY OF WET CHEMICAL WATER ANALYSES
ALLUVIAL AQUIFER
TRACT C-a AND VICINITY
(mg/l)

Item	Low	High	Average	No. Items Avg.
Aluminum	<0.100	<0.100	0.0	4
Ammonia	<0.100	1.000	0.342	19
Arsenic	<0.010	<0.010	0.0	20
Bicarbonate	370.000	710.000	555.750	20
Cadmium	<0.010	0.030	0.006	20
Calcium	28.000	210.000	101.900	20
Carbonate	<0.100	54.000	9.150	20
Chloride	7.000	71.000	19.045	20
Chromium	<0.050	<0.010	0.0	20
Copper	<0.100	0.100	0.010	20
Fluoride	<0.100	0.400	0.311	19
Hydroxide	--	--	0.0	0
Iron	<0.050	28.000	6.910	20
Lead	0.020	0.700	0.211	20
Magnesium	3.700	874.000	96.600	20
Mercury	<0.010	<0.010	0.0	20
Nitrate	0.100	13.000	3.935	20
Phosphate	<0.100	0.100	0.005	20
Potassium	--	--	0.0	0
Selenium	<0.100	<0.010	0.0	20
Silicon Dioxide	22.000	40.000	30.700	20
Sodium	75.000	300.000	199.500	20
Sulfate	145.000	580.000	365.000	20
Sulfide	--	--	0.0	0
Zinc	<0.100	0.600	0.212	19
Gross Alpha	--	--	0.0	0
Gross Beta	--	--	0.0	0
Hardness	280.000	750.000	488.750	20
pH	6.000	6.800	6.450	20
Conductance	860.000	1940.000	1385.300	20
Dissolved Solids	640.000	1460.000	1085.000	20
Manganese	<0.050	6.400	1.372	20
Alkalinity	329.000	580.000	464.255	20
Cyanide	<0.010	0.010	0.000	20
Boron	<0.010	27.000	3.248	20
Barium	<1.000	<1.000	0.0	20
Silver	<0.010	<0.010	0.0	20
Nickel	<0.010	0.100	0.047	20
Lithium	--	--	0.0	0
Toc	7.000	100.000	35.500	16

Water levels in alluvial wells G-S S7, G-S S8, G-S S11, and G-S S12 have been monitored since January 17, 1975. Water levels in G-S S7 and G-S S12 have remained relatively stable with some fluctuations occurring in G-S S7 from mid-April to mid-June, 1975. G-S S8 and G-S S11 water levels remained stable through mid-April, at which time water level rises began and steadily continued through May, 1975. The somewhat earlier rise in water level in G-S S11 is noted. The continuing rise in G-S S11 and the rise in G-S S8 are most likely due to percolation of spring runoff.

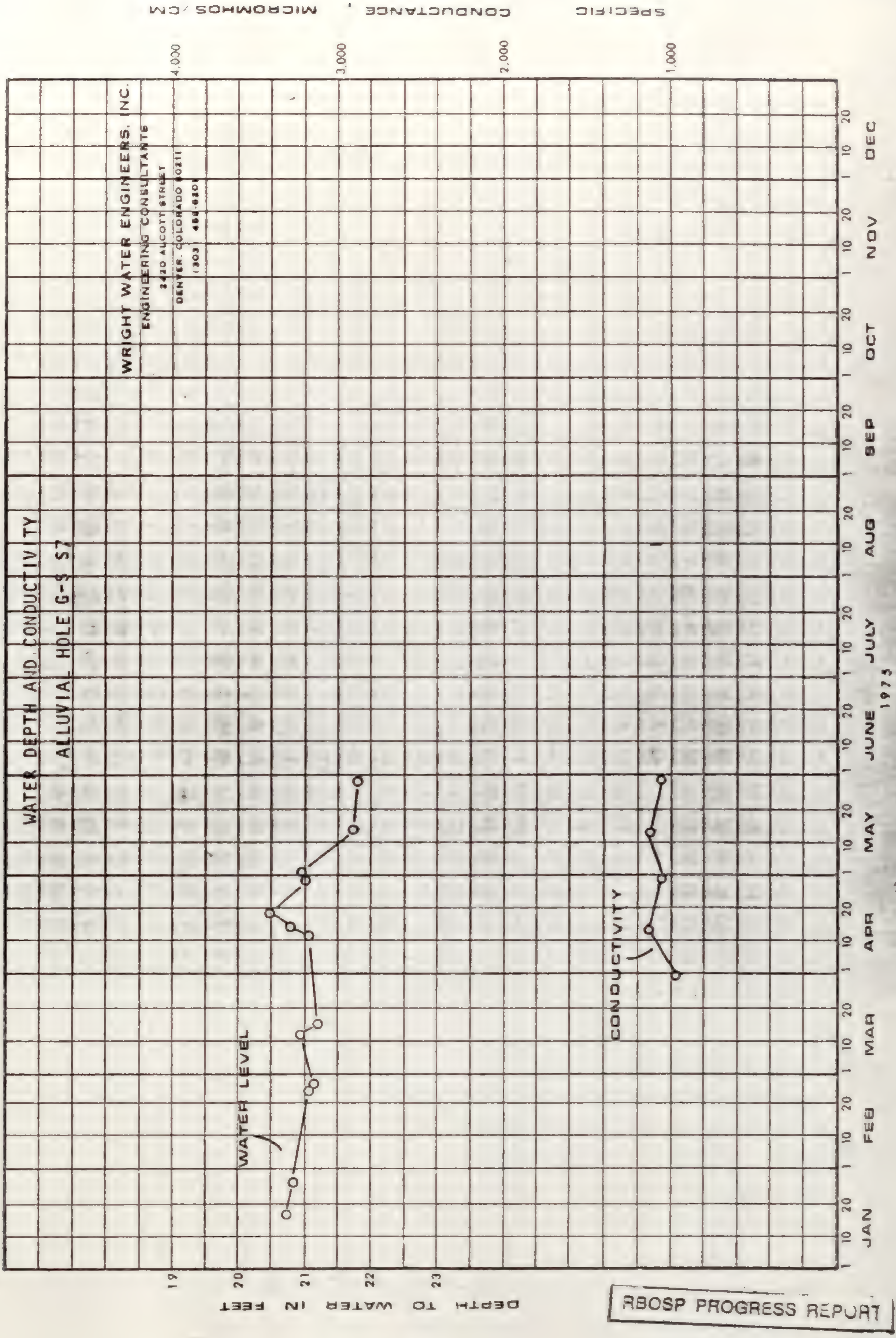


FIGURE 1.2

RBOSP PROGRESS REPORT

Figure 1.2-11

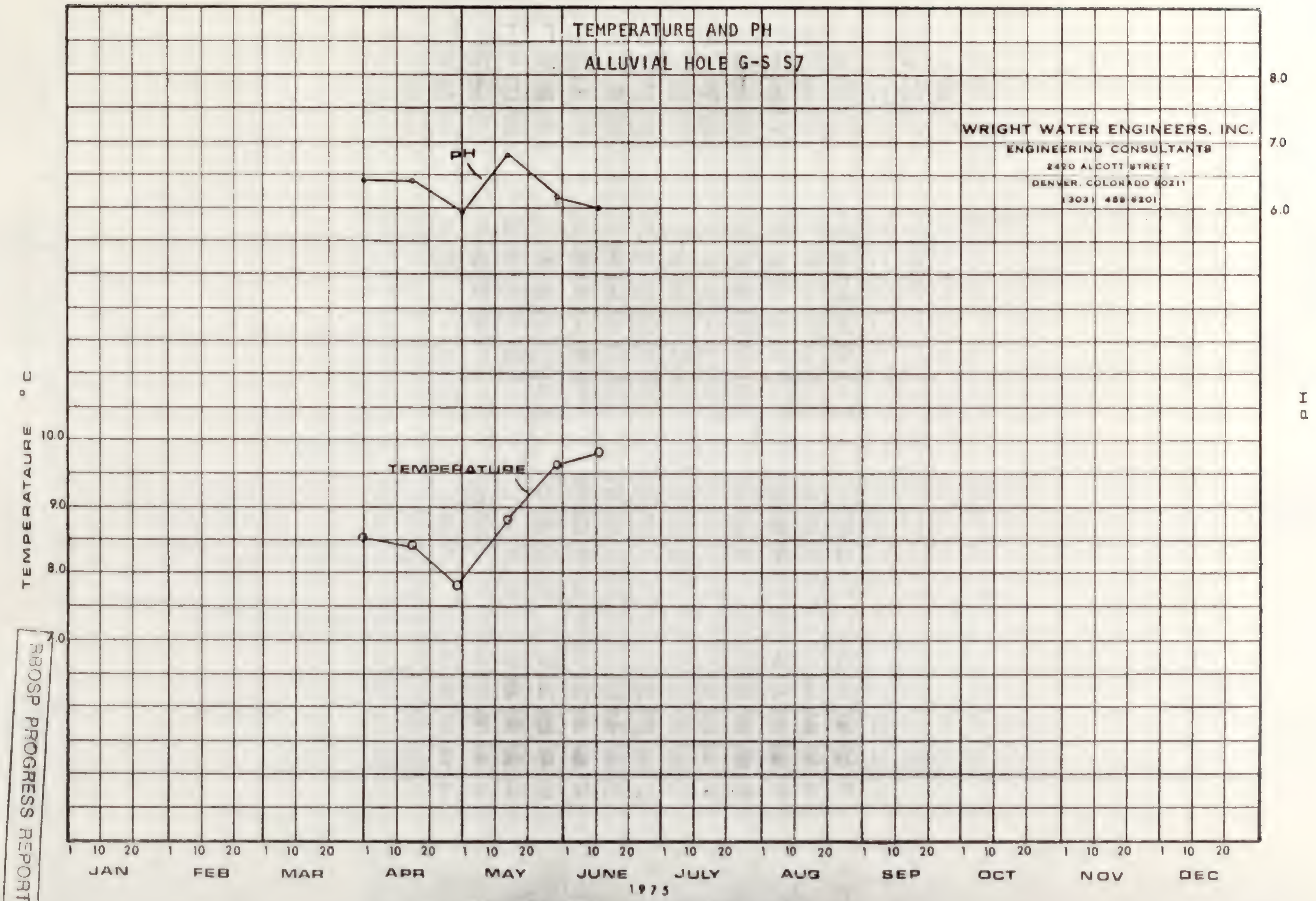
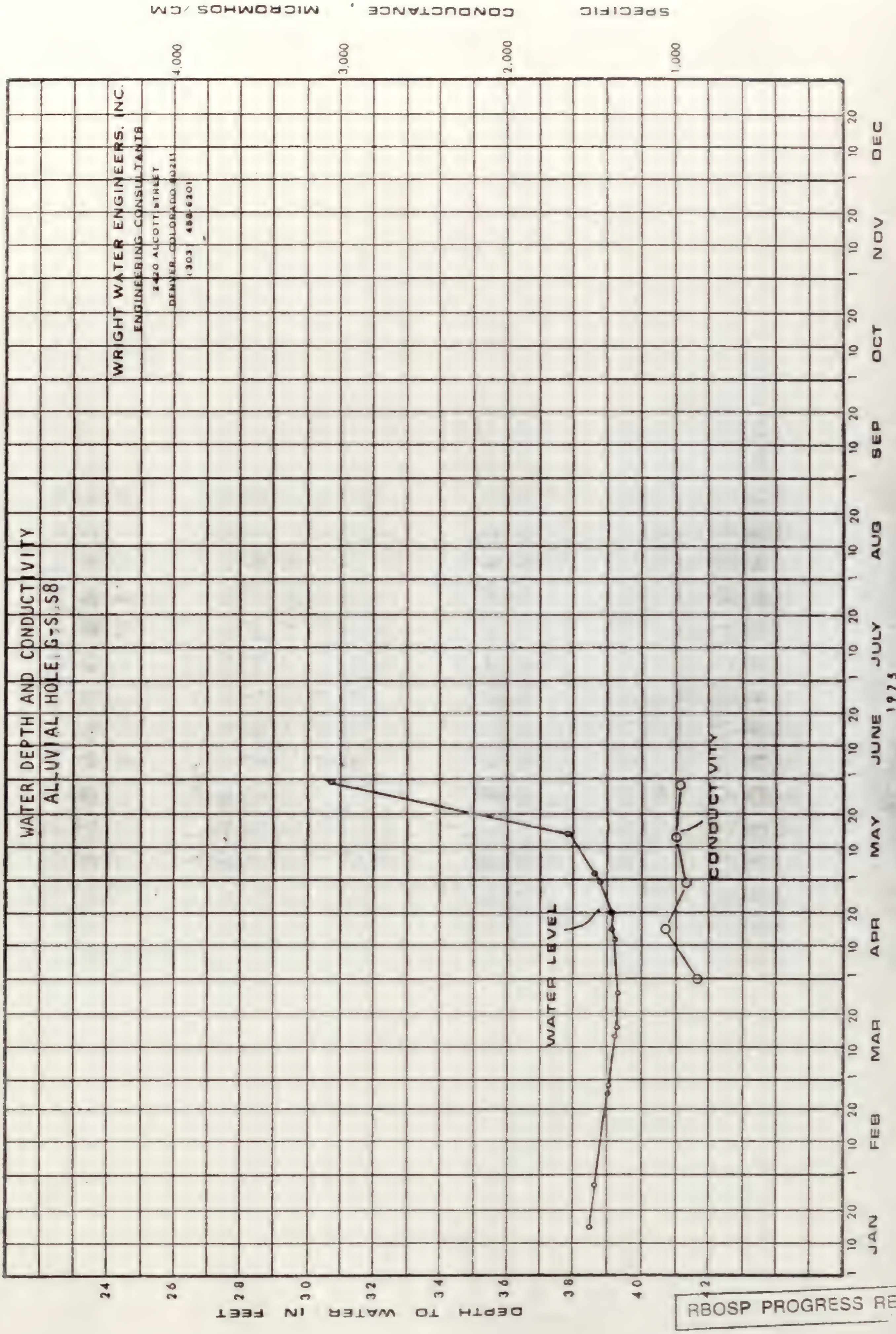


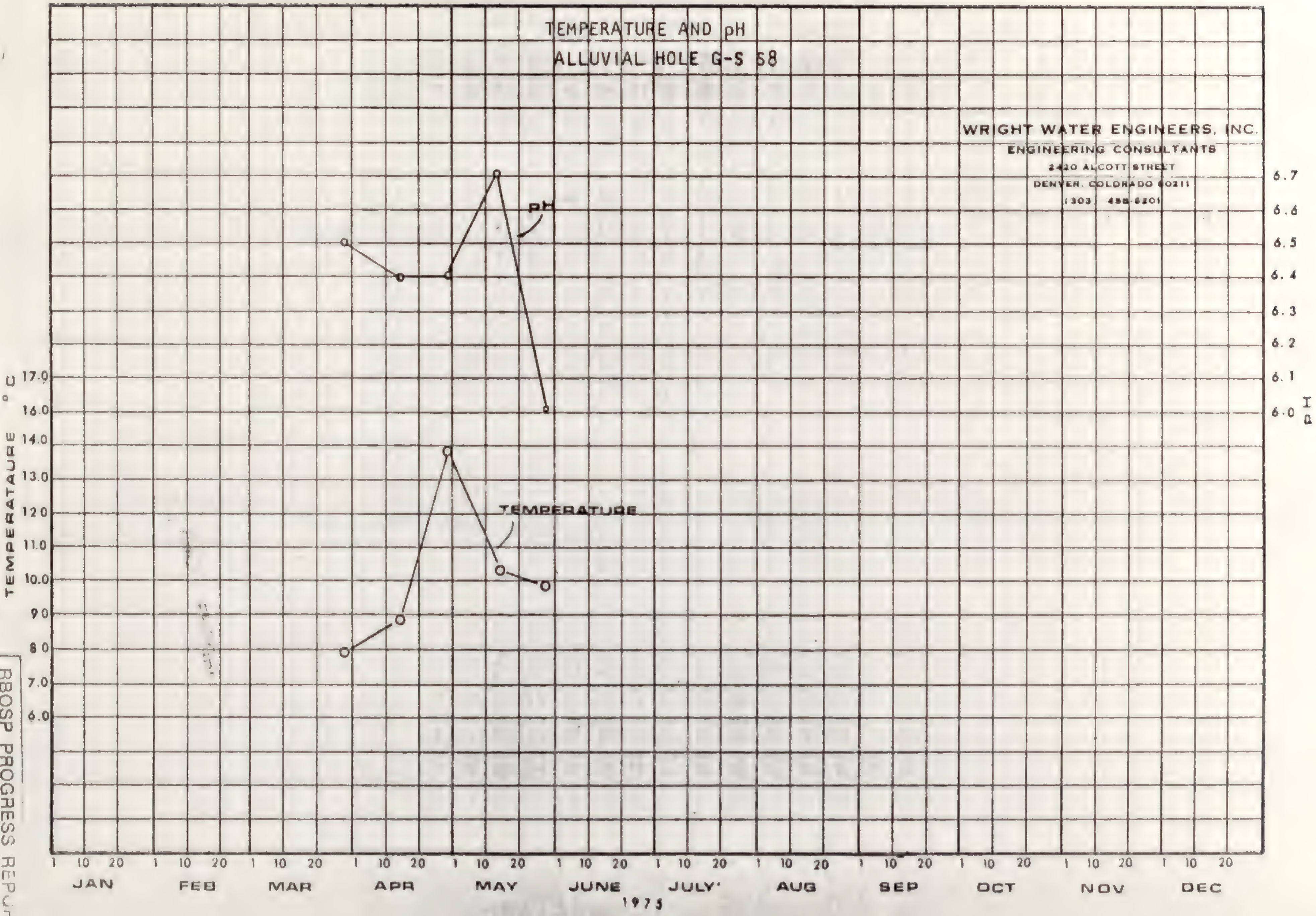
FIGURE 1.2

Figure 1.2-12

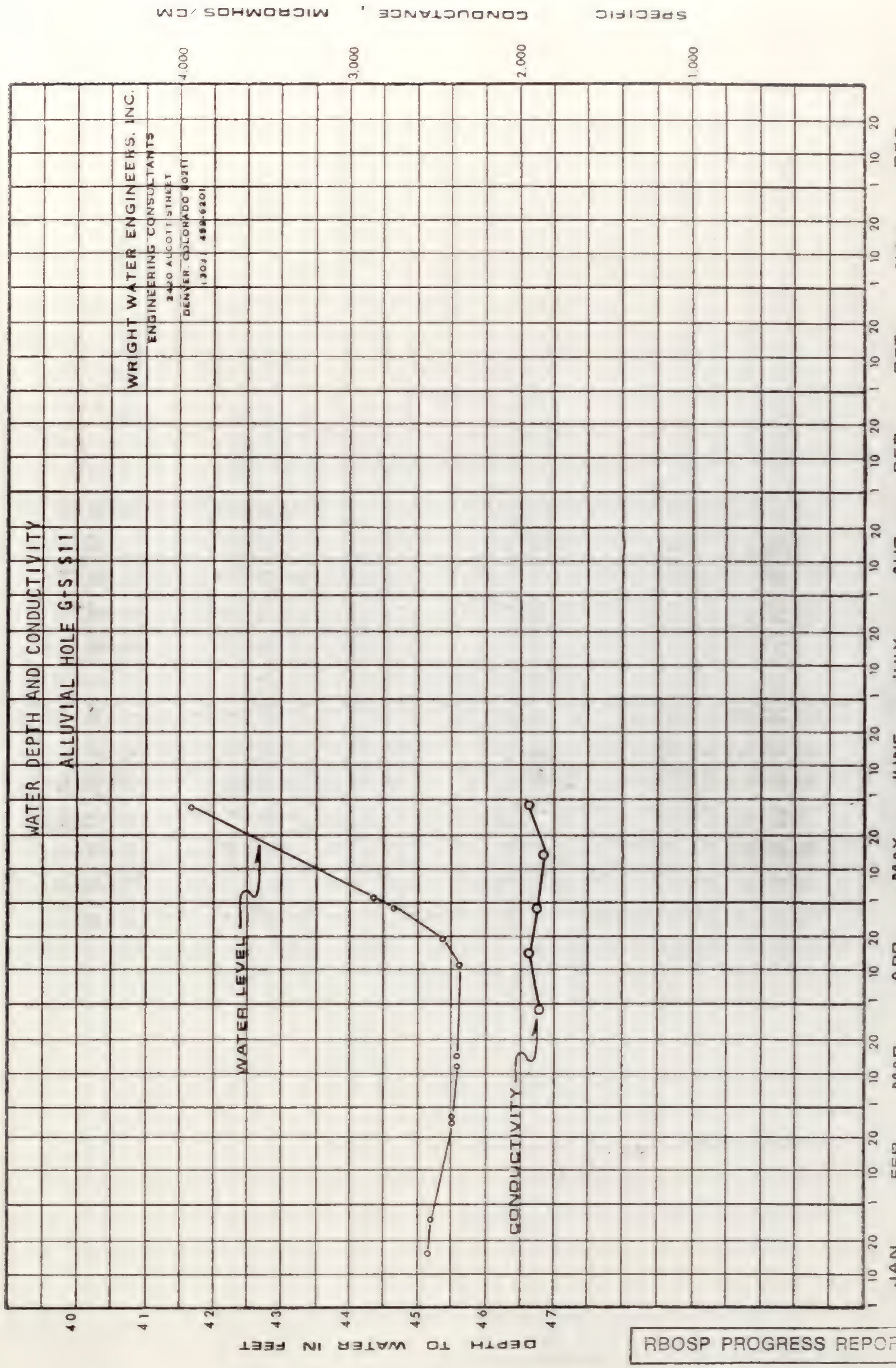


RBOSP PROGRESS REPORT

Figure 1.2-13

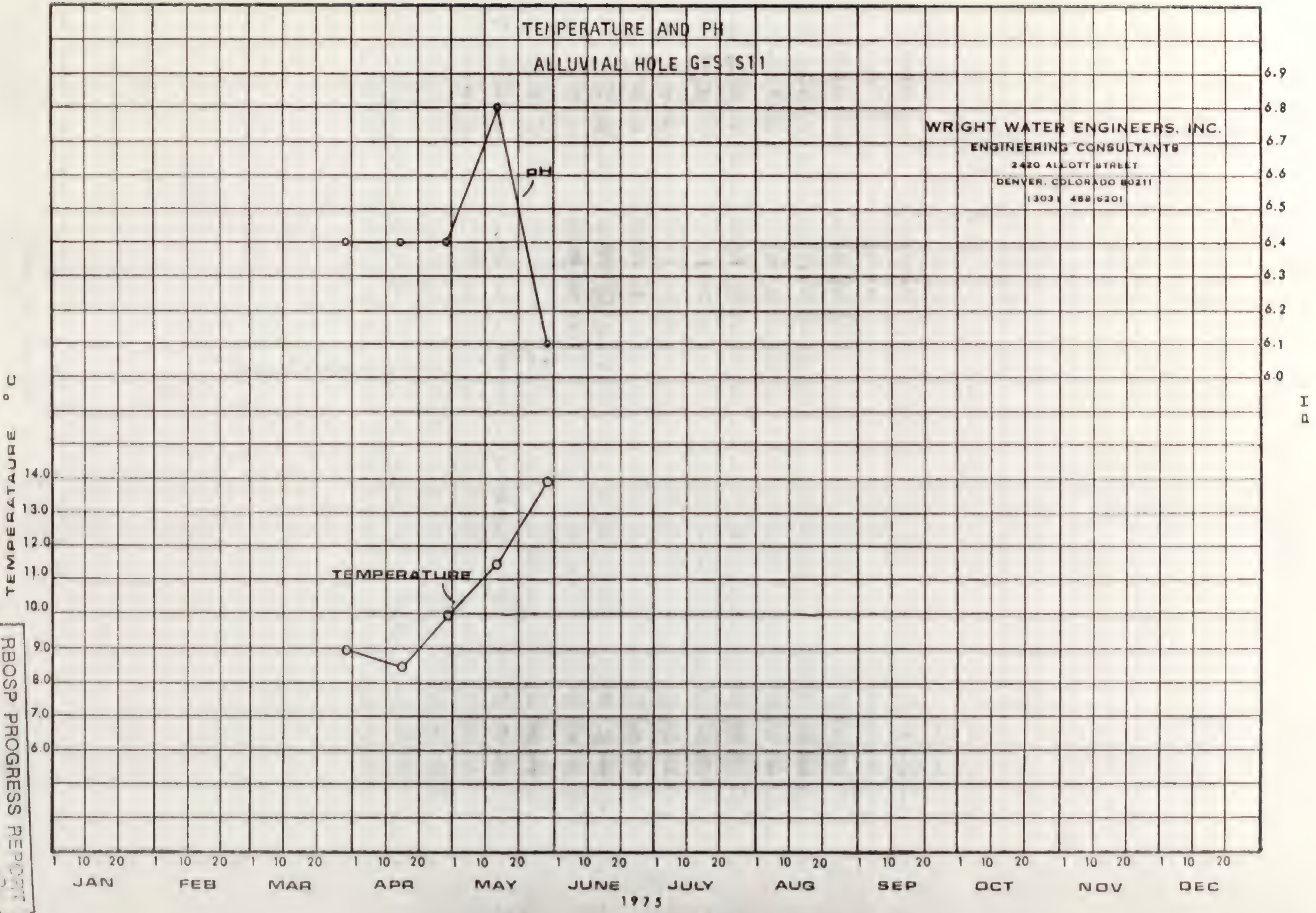

TEMPERATURE AND pH
ALLUVIAL HOLE G-S 58
WRIGHT WATER ENGINEERS, INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211
(303) 458-6201
pH
TEMPERATURE
TEMPERATAURE °C
17.0
16.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
6.7
6.6
6.5
6.4
6.3
6.2
6.1
6.0
pH
1 10 20
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
1975

Fugure 1.2-14



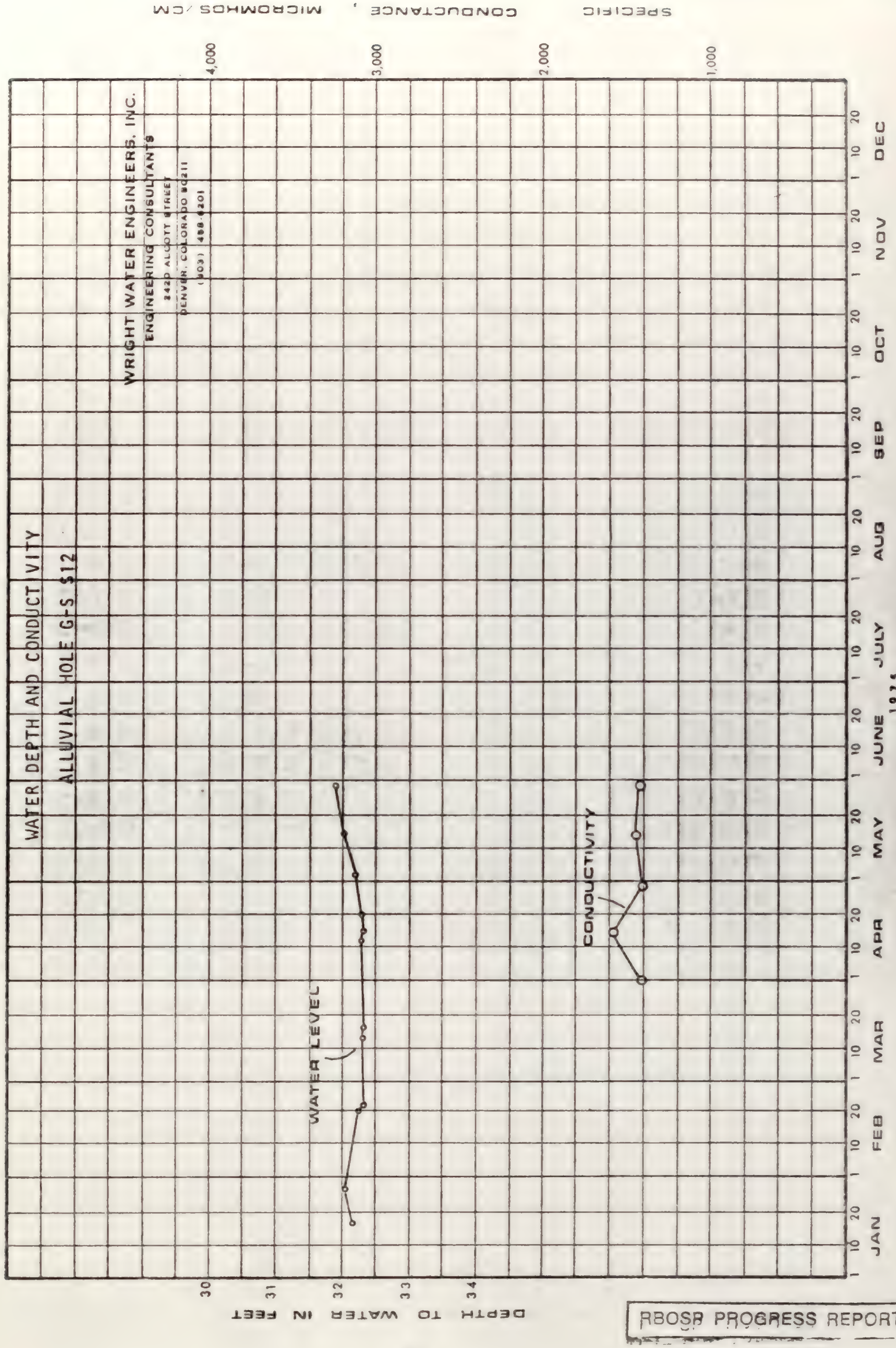
RBOSP PROGRESS REPORT

Figure 1.2-15



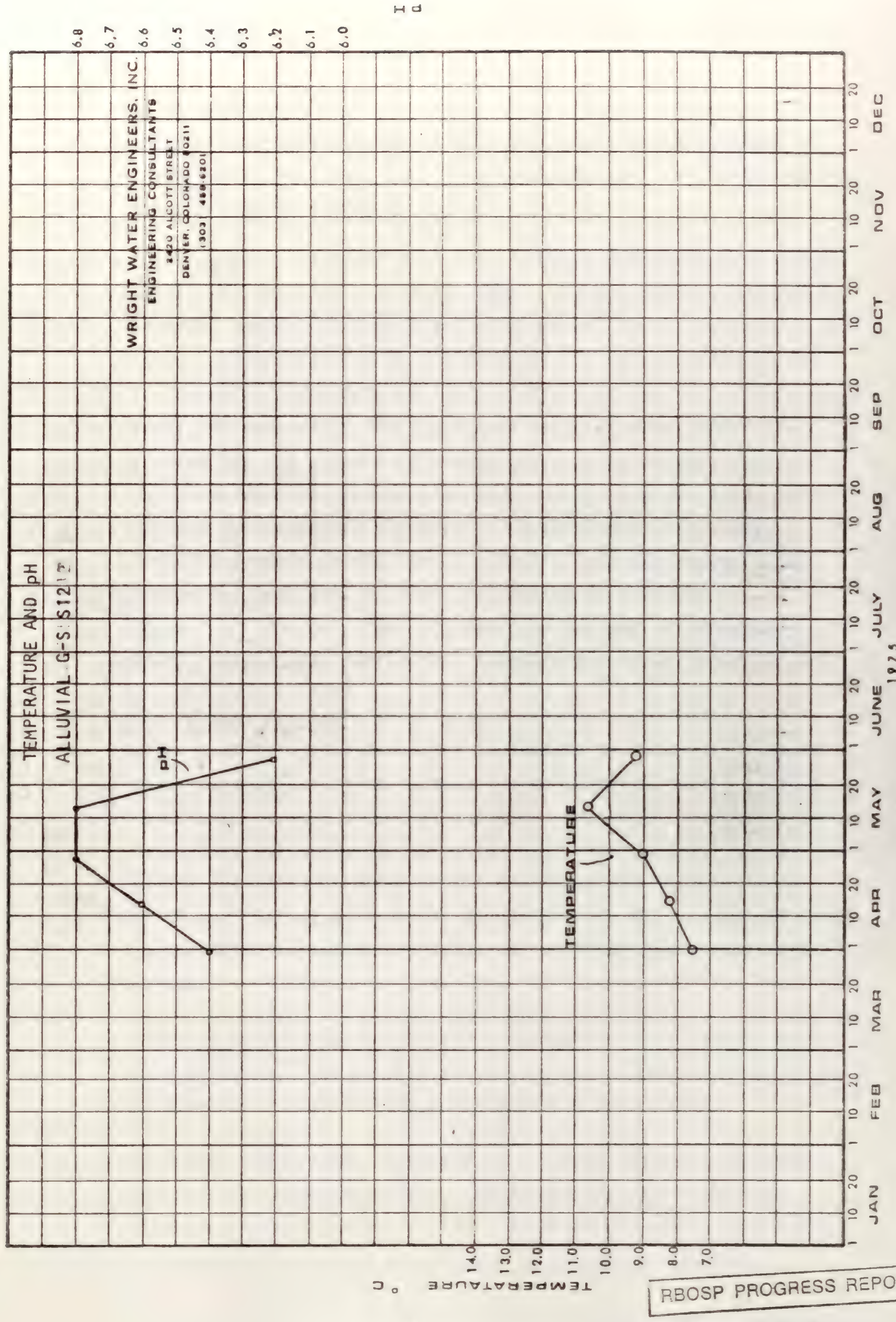
RBOSP PROGRESS REPORT

Figure 1.2-16



RBOSP PROGRESS REPORT

Figure 1.2-17



RBOSP PROGRESS REPORT

Figure 1.2-18

1.2.4 DRILLING PROGRAM

Specific hydrologic baseline data collected during drilling is contained in Section 1.2.4, Progress Report 2. The following is a summary of this program.

Drilling by RBOSP began with core hole G-S S6 during the first week of July, 1974. The program was concluded with the completion of G-S D19 in December, 1974. Thirteen core holes were drilled for the purposes of retrieving core samples to determine subsurface geologic conditions, and for delineating local and regional hydrology. Four large diameter holes were drilled for the purpose of conducting pumping tests. Four monitor holes were drilled to provide information about local hydrology and for ongoing water quality sampling and water-level monitoring north of the tract. A hydrologic program was conducted for each hole on tract C-a during drilling by RBOSP Water production was monitored continuously, while water quality was determined at least every 30 feet.

All measurements were taken with reference to drilling depth. Water quality constituents field measured included pH, temperature, conductivity, and in some cases, fluoride, boron and H_2S. Water samples were collected and forwarded to an independent laboratory for analysis. An upper limit for conductivity was set by the area oil shale supervisor for water discharged during drilling. During drilling of G-S M2 and G-S M3, discharged water conductivity exceeded this limit and drilling was consequently halted.

Normally an informal pump test was conducted twice during core hole drilling. These tests allowed an approximate determination of apparent transmissivities and specific capacities.

Bore hole geophysical logs were run on each hole and included spinner and temperature logs. Interpretation of these logs allowed a determination of flow: downhole or uphole flow (gpm), and zones of bore hole water entry or discharge (gpm/ft).

1.2.5 COMPLETION PROGRAM

RBOSP Progress Report 2 described in detail the completion program. Thirty holes (including pre-lease holes) were completed for deep aquifer monitoring. Twenty-two of these were completed for upper and lower aquifer monitoring, three for upper aquifer only, and five for lower aquifer only.

At the request of the USGS Water Resources Division pre-lease core holes had been left open allowing the two aquifers to inter communicate. RBOSP has either plugged and abandoned these holes or converted them to dual aquifer monitor holes. This completion method was used because it allowed the greatest flexibility for additional testing. The dual monitor hole completion was done by lowering a 5½-inch liner to a depth approximately 250 feet below the bottom of the upper aquifer; then 200 feet of this liner was cemented in place. The liner above the cement was removed. A 2-3/8-inch tubing was used to set a tension-type packer at about 30 feet below the top of liner to act as a seal to isolate the two aquifer systems. To assure data could be collected from the upper aquifer, a second string of 2-3/8 or 1¼-inch tubing was run. Table 1.2-7 is a revised Drill Hole Completion Summary.

G-S 12 and G-S 4-5 were completed as dual monitor holes but were temporarily modified to serve as upper aquifer pumping test holes. This modification (in order to effectively separate the two aquifers) entailed installing a temporary bridge-plug (packer) in the 5½-inch liner (see construction Figure 1-17, page 1-47, RBOSP Progress Report 2 - Summary) so that strata producing water which was open to the hole above the packer could be pump tested. Following the pump testing, the holes were returned to dual completion monitor holes.

Table 1.2-7

DRILL HOLE COMPLETION SUMMARY

Thirty On-Tract Holes

Drill Hole	Completion	Drill Hole	Completion
G-S 1	U&L	Am 4	P&A
G-S 2-3	U&L	CE - 701	Upper Aquifer Pump Test
G-S 4-5*	U&L*	CE - 702	U&L
G-S 6	U&L	CE - 703	P&A
G-S 7	P&A	CE - 705-A	Upper Aquifer Pump Test
G-S 8	Lower Aquifer Only	CE - 707	U&L
G-S 9	U&L	CE - 708	U&L
G-S 10	U&L	CE - 709	U&L
G-S 11	U&L	TO 1	U&L
G-S 12*	U&L*	TO 2	U&L
G-S 13	U&L	TO 3	Upper Aquifer Pump Test
G-S 14	P&A	G-S D16	Lower Aquifer Pump Test
G-S 15	U&L	G-S D17	Lower Aquifer Pump Test
Am 2-A	U&L	G-S D18	Lower Aquifer Pump Test
Am 3	U&L	G-S D19	Lower Aquifer Pump Test

Four Off-Tract Holes

Drill Hole	Completion
G-S M 1	U&L
G-S M 2	U&L
G-S M 3	U&L
G-S M 4	U&L

Totals

Completions in Upper and Lower Aquifers	22
Completions in Upper Aquifer Only	3
Completions in Lower Aquifer Only	5
Holes Plugged and Abandoned	4
Total Number of Holes	34

Am = Amoco Production Company
CE = Cameron Engineers, Inc.
G-S = Gulf-Standard (Indiana)
TO = The Oil Shale Company
U&L = Upper and Lower Aquifer Completions
P&A = Plugged and Abandoned

*Holes Temporarily Modified for Upper Aquifer Pump Testing

1.2.6 UPPER AND LOWER AQUIFER PUMPING TESTS

As part of the exploration plan, as amended and approved by the area oil shale supervisor, four upper aquifer pump tests and four lower aquifer pump tests were conducted. These pump tests were conducted to determine aquifer characteristics such as transmissivity, coefficient of storage, leaky conditions and boundary and recharge barriers. The tests began in January, 1975, and were concluded in June, 1975.

The aquifer tests included the monitoring of drawdown and recovery in both the production hole and all observation holes. Figure 1.2-19 shows the various hole locations. The water levels in the production holes were measured with an air line except for the second and third tests of CE 705A and G-S 4-5 for which an electric water-level indicator was used. All observation holes were monitored with an electric water-level indicator and are shown in the Appendix of this report; the back up is presented in Section 1.2.6 of RBOSP Progress Report 3, Raw Data. Production rates in gallons per minute were measured.

Submersible pumps were used. Pump installation diagrams are shown on Figures 1.2-20 through 1.2-29. These figures show the location of pump placement downhole with respect to the associated hole completion technique and aquifer location. Upper aquifer tests were conducted by pumping TO 3, CE 701, CE 705A, G-S 12 and G-S 4-5. Pumping test hole CE 701 was not successful in that the hole was pumped dry minutes after the pump was turned on. No further discussion of CE 701 as a pump testing hole will appear. Following the attempted pump test, CE 701 was monitored regularly as an observation hole. Lower aquifer pump tests were conducted at G-S D17, G-S D16, G-S D19, and simultaneously at G-S D18 and G-S D19. The pumping tests, including pumping rates and total time pumped, are shown in Table 1.2-8. The time required was longer than originally anticipated due to longer recovery periods required and some mechanical problems.

PUMPING RATES & TIMES

Pumped Hole	Date Pump Turned On	Time Pump Turned On	Date Pump Turned Off	Time Pump Turned Off	Gallons Pumped per Minute	Total Time of Pumping (Min.)
Upper Aquifer						
CE-705-A	2/26/75	1230	3/ 8/75	0850	72	14180
CE-705-A	3/19/75	0905	3/22/75	1405	264	4620
CE-705-A	3/25/75	0825	4/ 1/75	1515	259	10490
GS-4-5	5/ 2/75	0945	5/19/75	0715	81.3	24330
GS-12	4/ 2/75	1045	4/13/75	0845	64.3	15720
TO-3	1/ 7/75	1000	1/28/75	1310	76.7	30430
Lower Aquifer						
GS-16	2/11/75 (Step Drawdown)	0945	2/11/75	1800	151 200 250	495
GS-16	2/15/75	1300	3/ 9/75	1230	123	31650
GS-17	1/ 6/75	1600	1/11/75	0928	275	6808
GS-17	1/18/75	1300	2/ 3/75	0830	275	22770
GS-18	5/21/75	1030	6/ 5/75	1100	174	21630
GS-19	4/ 8/75	1100	5/ 5/75	0030	667	38250
GS-19	5/20/75	1000	5/26/75	0655	667	8455

Table 1.2-8

RBOSP PROGRESS REPORT

During the pumping tests, the temperature, conductivity, and pH were monitored. The results of these data are shown in Figures 1.2-30 through 1.2-38. Water samples were also collected for laboratory analysis. Tables 1.2-9 and 1.2-9A are summaries of the wet chemical and spectographic analyses, respectively, of water samples from the upper and lower aquifers and of samples of the combined water from both aquifers. These tables include data from the drilling and monitoring program as well as the pump testing program. The individual sample analysis is contained in Section 1.2.6 of RBOSP Progress Report 3, Raw Data. The samples are identified as to the origin by the name of the hole from which they came and also the method number from each data sheet. The drilling program is designated method number one (1). The pump testing data is designated method number two (2). The monitoring program has been designated method number three (3). From time to time the fluid used during drilling was analyzed and has been designated method number zero (0). In future progress reports the water quality data will be presented under Section 1.2.7, Deep Aquifer Monitoring. The water quality of the upper aquifer was stable over the pumping period except at the initiation of pumping. This initial change in conductivity and pH is due to the removal of fluids introduced during drilling. For the upper aquifer, pH averaged from 6.8 to about 7.5 for the wells tested.

Temperature fluctuated during the first stages of pumping and tended to stabilize after a few days of pumping. Upper aquifer pumping tests in holes G-S 12 and CE 705A produced the lowest temperature water, averaging about 14°C. G-S 4-5 produced water at a relatively constant value of 17°C. TO 3, in contrast, showed fluctuating temperature values that averaged 23°C.

Conductivity fluctuated or dropped at the start of most pumping tests but stabilized shortly thereafter. In the upper aquifer, conductivity from G-S 12, CE 705A and G-S 4-5 ranged from about

TABLE 1.2-9

SUMMARY OF WET CHEMICAL WATER ANALYSIS UPPER, LOWER, AND COMBINED AQUIFERS TRACT C-a AND VICINITY

Item	Lower Aquifer				Upper Aquifer				Combined Aquifer			
	From Monitoring & Pumping				From Drilling, Monitoring, & Pumping				From Drilling			
	Low	High	Average	No. Items Avg.	Low	High	Average	No. Items Avg.	Low	High	Average	No. Items Avg.
Aluminum	-0.100	1.600	0.120	45	-0.100	2.200	0.176	46	-0.100	0.100	0.005	21
Ammonia	-0.100	5.600	0.601	79	-0.100	10.600	0.766	100	-0.100	3.000	0.974	28
Arsenic	-0.050	0.050	0.001	99	-0.050	0.200	0.005	111	-0.100	0.500	0.038	30
Bicarbonate	-0.100	11800.000	1143.114	114	-0.100	2690.000	625.259	139	350.000	19600.000	2073.000	58
Cadmium	-0.010	0.030	0.002	100	-0.010	0.030	0.002	95	-0.010	0.070	0.009	24
Calcium	-1.000	515.000	48.877	114	3.100	780.000	72.984	139	0.100	88.000	26.290	58
Carbonate	-1.000	3160.000	97.721	114	-0.100	1190.000	34.368	138	-0.100	3000.000	163.982	57
Chloride	-1.000	205.000	37.952	114	-1.000	240.000	29.194	139	3.000	6600.000	238.352	58
Chromium	-0.050	0.010	0.000	95	-0.050	0.500	0.009	96	-0.050	0.570	0.057	24
Copper	-0.100	0.200	0.014	100	-0.100	0.780	0.024	95	-0.100	0.100	0.004	24
Fluoride	-0.050	120.000	13.347	115	0.060	80.000	4.993	139	0.200	60.000	12.869	58
Hydroxide	-0.100	890.000	221.250	8	-0.100	380.000	9.268	41	-0.100	-0.100	0.0	30
Iron	-0.050	33.000	2.343	114	-0.050	16.000	1.841	123	-0.050	16.000	0.685	51
Lead	-0.050	4.600	0.285	100	-0.050	3.400	0.287	95	-0.050	0.500	0.065	24
Magnesium	-1.000	140.000	39.154	114	-0.100	140.000	48.330	138	0.700	96.000	27.265	57
Mercury	-0.010	0.002	0.000	96	-0.010	0.045	0.001	98	-0.010	-0.010	0.0	16
Nitrate	-0.100	55.000	0.977	114	-0.100	5.000	0.456	139	-0.100	15.000	1.152	58
Phosphate	-0.100	2.400	0.060	101	-0.100	9.200	0.288	98	-0.100	8.200	2.425	24
Potassium	-1.000	84.000	26.800	5	-1.000	93.000	12.773	41	-1.000	76.000	15.167	30
Selenium	-0.010	-0.001	0.0	100	-0.100	0.010	0.000	112	-0.100	0.010	0.000	30
Silicon Dioxide	-0.100	50.000	12.675	114	-0.100	58.000	25.737	139	6.400	41.000	17.790	58
Sodium	86.000	5290.000	552.026	114	40.000	1170.000	274.381	139	165.000	12000.000	1007.276	58
Sulfate	-5.000	740.000	244.522	114	-4.000	800.000	324.547	139	-4.000	535.000	180.534	58
Sulfide	-0.010	2.400	1.467	3	-1.000	4.100	1.556	18	-1.000	12.000	2.753	19
Zinc	-0.500	10.000	0.537	100	-0.500	4.400	0.409	86	-0.500	1.000	0.286	14
Gross Alpha	0.300	23.000	7.486	22	0.900	10.000	4.500	21	0.500	12.000	6.675	8
Gross Beta	4.000	260.000	40.545	11	13.000	38.000	22.333	3	1.000	57.000	26.229	7
Hardness	20.000	1260.000	281.131	114	32.000	1870.000	379.503	139	30.000	520.000	175.000	57
Ph	6.000	12.200	7.328	114	6.000	10.200	7.142	139	6.800	8.800	7.904	57
Conductance	760.000	15800.000	2469.750	112	675.000	6200.000	1518.623	138	880.000	28000.000	3426.754	57
Diss. Solids	430.000	12200.000	1682.257	113	425.000	3140.000	1165.762	139	650.000	30700.000	2869.509	57
Manganese	-0.050	0.400	0.058	108	-0.100	0.780	0.099	111	-0.200	0.320	0.018	40
Alkalinity	-0.100	10480.000	965.895	109	-0.100	2360.000	530.599	97	31.000	9310.000	1069.629	27
Cyanide	-0.100	-0.010	0.0	94	-0.010	-0.010	0.0	70	--	--	0.0	0
Boron	-0.100	25.000	2.130	97	-0.100	4.400	0.760	82	-0.100	1.500	0.620	10
Barium	-1.000	-0.100	0.0	95	-1.000	-1.000	0.0	71	--	--	0.0	0
Silver	-0.010	0.110	0.006	95	-0.010	0.100	0.012	71	--	--	0.0	0
Nickel	-0.100	0.100	0.020	93	-0.010	0.200	0.024	71	--	--	0.0	0
Lithium	--	--	0.0	0	-0.500	-0.500	0.0	2	--	--	0.0	0
TOC	2.000	37.000	9.227	44	-1.000	27.000	7.477	44	--	--	0.0	0

SUMMARY OF QUALITATIVE SPECTOGRAPHIC ANALYSIS

Item	Lower Aquifer From Monitoring & Pumping				Upper Aquifer From Drilling, Monitoring and Pumping				Combined Aquifer From Drilling			
	Low	High	Average	No. Items Avg.	Low	High	Average	No. Items Avg.	Low	High	Average	No. Items Avg.
Aluminum	0.010	1.000	0.199	45	0.010	1.000	0.172	74	0.010	1.000	0.182	50
Antimony	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Arsenic	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Barium	0.001	0.100	0.042	9	0.001	0.050	0.015	6	0.100	0.100	0.100	1
Beryllium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Bismuth	--	--	0.0	0	--	--	0.0	0	0.100	0.100	0.100	1
Boron	0.050	99999.000	0.608	45	-0.020	5.000	0.350	74	0.050	5.000	0.456	53
Cadmium	99999.000	99999.000	0.0	0	99999.000	99999.000	0.0	0	--	--	0.0	0
Calcium	5.000	99999.000	8.000	5	1.000	99999.000	5.500	2	2.000	99999.000	5.500	4
Cerium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Cesium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Chromium	0.010	0.010	0.010	1	0.000	0.050	0.010	13	0.001	0.050	0.012	13
Cobolt	--	--	0.0	0	0.001	0.001	0.001	1	--	--	0.0	0
Columbium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Copper	0.001	0.100	0.012	37	0.000	0.050	0.014	45	0.000	0.050	0.006	30
Dysprosium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Erbium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Europium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Gadolinium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Gallium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Germanium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Gold	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Hafnium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Holmium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Indium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Iridium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Iron	0.005	5.000	0.341	47	0.010	1.000	0.130	72	0.010	10.000	0.518	50
Lanthanum	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Lead	0 050	0.050	0.050	3	0.001	0.500	0.094	8	0.005	0.500	0.129	9
Lithium	0 001	5.000	0.179	32	-0.500	0.200	0.056	43	-0.500	1.000	0.153	36
Lutetium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Magnesium	5 000	99999.000	5.714	7	5 000	99999.000	8.000	5	1.000	99999.000	6.750	12
Manganese	0 001	0.100	0.017	32	0.001	1.000	0.057	41	0.010	10.000	0.520	22
Mercury	-	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Molybdenum	0 001	0.010	0.003	18	0.001	0.050	0.007	32	0.001	0.061	0.012	28
Neodymium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Nickel	--	--	0.0	0	0.001	0.010	0.005	2	--	--	0.0	0
Osmium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Palladium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Platinum	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Potassium	0.010	99999.000	2.214	40	0.050	99999.000	1.409	59	0.100	99999.000	1.538	42
Praseodymium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Radium	0.400	0.400	0.400	1	0.100	0.300	0.175	4	0.300	0.500	0.400	3
Rhenium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Rhodium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Rubidium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Ruthenium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Samarium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Scandium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Selenium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Silicon	-0.500	99999 000	8.023	44	2.000	50.000	16.932	74	5.000	99999.000	16.245	53
Silver	0.000	0.001	0.001	10	-0.001	0.001	0.000	11	0.000	0.000	0.000	3
Sodium	0.100	99999.000	5.025	4	2.000	99999.000	5.667	3	99999.000	99999.000	0.0	0
Strontium	0.010	1.000	0.197	40	0.100	1.000	0.215	53	0.100	0.500	0.185	34
Tantalum	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Terbium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Thallium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Thorium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Thulium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Tin	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Titanium	0.001	0.050	0.008	27	0.001	0.150	0.021	45	0.001	0.200	0.020	38
Tungsten	--	--	0.0	0	--	--	0 0	0	--	--	0.0	0
Uranium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Vanadium	--	--	0.0	0	0.001	0.100	0.027	16	0.001	0.050	0.019	19
Ytterbium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Yttrium	--	--	0.0	0	--	--	0.0	0	--	--	0.0	0
Zinc	0.001	0.500	0.117	9	0.010	0.500	0.144	5	0.005	0.100	0.041	4
Zirconium	--	--	0.0	0	--	--	--	0	--	--	0.0	0

Table 1,2-9A

1350 umhos/cm to 1750 umhos/cm. TO 3, however, averaged higher: 3500 umhos/cm. This is possibly due to interconnection with higher conductivity water from the lower aquifer.

Quality of water from the lower aquifer was poorer than upper aquifer water. Water from G-S D16, G-S D19, and G-S D18 had relatively stable 7.5 pH average. G-S D17 fluctuated between 6.0 and 7.3. Temperature from G-S D19 water increased gradually from 17°C to 19°C. Temperatures in the other wells fluctuated: G-S D16 ranged from 24°C to 27°C and stabilized at 27°C about mid-test; G-S D17 ranged from about 13° to 18°C; and G-S D18 ranged from a stable 30°C mid-test to a fluctuating range of 28° to 30°C.

Conductivity from G-S D17 water was generally stable at 1700 umhos/cm. G-S D18 conductivity stabilized just less than 5000 umhos/cm. Higher conductivities are probably due to the solution of leachable salts as the water moves through the aquifer. G-S D19 water conductivity gradually increased from 1800 umhos/cm to 2400 umhos/cm. G-S D16 conductivity gradually dropped from about 4200 to 3800 umhos/cm.

Values of transmissivity, T, and coefficients of storage, S, for the pumped hole and all affected observations holes were computer calculated using the simplified Jacob's method. Raw Data, Volume 3, Section 1.2.3 contains these calculations. The semi logarithmic plots for the pumped holes and monitor holes are presented in the Interpretive Text Appendix. The T's and S's summarized in Table 1.2-10 are an arithmetic mean of the representative T's and S's from the pumping tests. The average T's and S's given in the text for the upper and lower aquifers are an arithmetic mean of the values given in Table 1.2-10.

The effects of the upper aquifer pumping tests were observed primarily only in nearby holes. The average T and S during drawdowns were 15,316 gpd/foot and 6.8×10^{-5} respectively. The

PUMPING TEST
SUMMARY

Pumping Hole	Average Drawdown		Average Recovery	
	T	S	T	S
Upper Aquifer				
CE-705A	--	--	25925 (2)	1.86E-5 (1)
CE-705A	17767 (3)	2.26E-5 (2)	16990 (3)	3.31E-5 (2)
CE-705A	29348 (4)	4.51E-5 (3)	24891 (4)	4.22E-5 (2)
GS-4-5			5176 (1)	--
GS-12	2381 (4)	1.06E-4 (3)	7569 (2)	2.72E-6 (1)
TO-3	11769 (3)	9.9E-5 (3)	20905 (2)	2.02E-4 (2)
Lower Aquifer				
GS-16	--	--	--	--
GS-16	6458 (22)	1.19E-4 (22)	58109 (11)	1.91E-5 (11)
GS-17	12218 (7)	1.09E-4 (7)	19025 (10)	1.41E-4 (8)
GS-17	7547 (21)	6.21E-5 (20)	24602 (18)	6.76E-5 (18)
GS-18	--	--	22843 (21)	5.38E-5 (20)
GS-19	7041 (22)	1.78E-4 (21)	22890 (22)	1.25E-4 (22)
GS-19	14598 (19)	8.04E-5 (18)	43461 (21)	1.65E-4 (20)

( ) number of observation holes used in calculation

Table 1.2-10

RBOSP PROGRESS REPORT

average T and S during recovery were 16,909 gpd/foot and 5.97×10^{-5} respectively.

Each of the pumping tests of the lower aquifer generally affected all of the lower aquifer observation holes with the exceptions of G-S M2 and G-S M3. The lack of effect in these holes is probably due to the partial penetration of the lower aquifer by these holes. The lower aquifer average transmissivities are less than the upper aquifer values, with an average T of 9572 gpd/foot and an S of 2.0×10^{-4}. The generally higher values of transmissivity and smaller coefficients of storage during recovery than during drawdown are probably due to the dewatering of the upper and lower aquifers during pumping, resulting in the aquifer never fully recovering from pumping. A summary of the transmissivity and coefficients of storage is presented in Table 1.2-10.

Table 1.2-11 shows transmissivity and coefficient of storage values for individual observation hole. Upper aquifer pumping of CE 705A resulted in drawdown in TO 1 on the pump hole site and in CE 709. The average T and S during drawdown were 23,557 gpd/foot and 3.38×10^{-5} respectively. The average T and S during recovery were 22,602 gpd/foot and 3.13×10^{-5} respectively. The first pumping test of CE 705 was suspended because of pump wear. A larger pump was installed in an attempt to affect nearby observation wells. The second test ended due to generator failure.

Drawdown during the pumping of G-S 4-5 upper aquifer was observed only in the production hole. The average T was 5145 gpd/foot. The recovery value was 5176 gpd/foot.

The pumping of G-S 12 upper aquifer affected the water levels in AM 2A, AM 3, and G-S 11. The average T and S for drawdown were 2381 gpd/foot and 1.06×10^{-4} respectively. During recovery the

TABLE 1.2-11

TRANSMISSIVITY & COEFFICIENT OF STORAGE

FROM UPPER AQUIFER DRAWDOWN TEST

Observation Hole	CE-705A 264 gpm		CE-705A 259 gpm		GS-4-5 81.3 gpm		GS-12 64.3 gpm		TO-3 76.7 gpm	
	T	S	T	S	T	S	T	S	T	S
AM-2A							3831	2.34E-4		
AM-3							2628	8.31E-5		
CE-702									10748	5.94E-6
CE-705A	513 4424 19879	-- -- --	4864 17313	-- --						
CE-709	22827	4.50E-5	24770	6.20E-5						
GS-2-3									1702	9.57E-5
GS-4-5					5114 3580	-- --				
GS-6									22858	1.97E-4
GS-11							1989 1156 1614	1.94E-6 2.97E-6 1.23E-6		
GS-12							1453	--		
GS-M2			63512	7.27E-5						
TO-1	3435 4955 10594	9.70E-4 3.00E-4 2.84E-7	4188 8212 11797	7.96E-4 9.74E-6 7.15E-8						
TO-3									108 604	-- --

FROM UPPER AQUIFER RECOVERY TEST

CE-702									2165 5972 17897	2.97E-3 2.72E-4 1.14E-9
CE-705A	6043 12125	-- --	6415 11955 30041	-- -- --						
CE-709	27829	6.61E-5	30417	5.49E-5						
GS-4-5					5176 2919	-- --				
GS-6									23913	3.84E-4
GS-11							6542 1431	2.72E-6 2.74E-6		
GS-12							8596 1568	-- --		
GS-M2			15242	2.95E-5						
TO-1	4421 6098 11015	9.12E-4 1.54E-4 2.68E-7	5865 14432 23865	2.96E-4 4.27E-9 5.68E-15						
TO-3									100	--

average T and S were 7569 gpd/foot and 2.72×10^{-6} respectively. Insufficient recovery data were obtained from AM 2A and AM 3.

CE 701 was pumped with a 15 hp unit at 60 gpm on February 5, 1975, and resulted in the hole being pumped down. The pumping program for this hole was terminated due to poor well efficiency, probably caused by hole completion problems.

The upper aquifer pumping of TO 3 resulted in drawdown in CE 702 on the test site and in G-S 6. The very low value of T for TO 3 compared to CE 702 is probably due to well loss. The values of T and S for CE 702 are representative of aquifer characteristics and are 10,748 gpd/foot and 5.94×10^{-6} respectively for drawdown. A value of 17,897 gpd/foot was determined for recovery.

There appears to be a connection between the upper and lower aquifers in the northeast corner of the tract in the area of CE 702, G-S 6, and TO 3, indicated by the drawdown and recovery of the upper aquifer during the pumping tests of G-S D19, and G-S D18 and G-S D19 simultaneously.

Tables 1.2-12 and 1.2-13 show values of transmissivity and coefficient of storage for each lower aquifer pumping test.

A step drawdown test of lower aquifer G-S D16 was conducted resulting in an average transmissivity of 15,538 gpd/foot. The average drawdown T and S for the long-term drawdown test of G-S D16 were 6458 gpd/foot and 1.19×10^{-4} respectively. Some of the observation holes had insufficient recovery to calculate a T or S.

The first lower aquifer G-S D17 test from 1/6/75 to 1/11/75 was conducted without previous baseline data and cannot be considered very reliable. The test was terminated with the failure of the generator. The results of the second test of G-S D17 from 1/18/75 to 2/3/75 had an average drawdown T and S of 7547 gpd/foot and 6.21×10^{-5} respectively.

TABLE 1.2-12

TRANSMISSIVITY & COEFFICIENT OF STORAGE
FROM
LOWER AQUIFER DRAWDOWN TEST

Observation Hole	GS-D16 174 gpm		GS-D17 275 gpm		GS-D17 275 gpm		GS-D19 667 gpm		GS-D19 667 gpm	
	T	S	T	S	T	S	T	S	T	S
AM-2A	21605	2.68E-4			8492	4.91E-5	19420	7.08E-5	17301	8.03E-5
	5774	3.99E-4					10943	1.13E-4		
							5766	1.48E-4		
AM-3	14192	2.62E-4			27533	5.68E-5	20520	1.08E-4	20689	1.23E-4
	6122	4.06E-4			7615	7.20E-5	11499	1.51E-4		
							5952	1.88E-4		
CE-702	24382	4.12E-5	17835	7.68E-5	44047	4.48E-5	22204	4.66E-5		
	7901	4.22E-5			12951	4.22E-5	12683	8.77E-5		
							7755	1.40E-4		
CE-707	11861	1.92E-5			10687	6.09E-5	14292	5.04E-5	12296	5.91E-5
	6635	3.38E-5			7205	8.98E-5	6936	1.11E-4		
CE-708	13522	3.17E-5			12839	5.63E-5	14533	8.66E-5	13993	1.00E-4
	6432	6.04E-5			7917	6.92E-5	10288	1.42E-4		
							5547	2.05E-4		
CE-709	7630	6.99E-5	9176	1.73E-4	19890	4.68E-5	14754	9.97E-5	11637	1.02E-4
					8967	5.75E-5	9474	1.76E-4		
					6339	8.53E-5	5879	3.13E-4		
GS-1	12871	2.26E-5	10014	5.23E-5	8712	8.33E-5	18633	6.01E-5	18524	5.89E-5
	6740	3.53E-5					11901	7.93E-5		
GS-2-3	12747	3.82E-5	11556	3.99E-5	7534	1.01E-4	12259	5.14E-5	10827	5.34E-5
	6674	4.51E-5					6303	1.07E-4		
GS-4-5	17487	3.96E-5	11757	3.08E-5	17322	4.40E-5	16221	5.10E-5		
	6742	4.70E-5			10555	4.42E-5				
					6972	6.13E-5				
GS-6	16546	5.71E-5	19379	1.89E-5	15031	3.21E-5	20694	5.34E-5	13377	5.78E-5
	7002	5.36E-5			8094	4.32E-5	10457	1.19E-5		
							6340	1.95E-4		
GS-8	19394	2.08E-4			8543	4.61E-5	12084	5.26E-5	11748	6.03E-5
	6327	2.38E-4			5479	5.95E-5	5890	1.27E-4		
GS-9	6277	6.83E-5			9505	6.14E-5	17266	1.65E-4	13223	2.13E-4
					5915	8.62E-5	12937	2.47E-4		
							5426	5.79E-4		
GS-10	20921	5.29E-5			11354	2.57E-5	19622	7.87E-5	14995	9.89E-5
	6642	7.69E-5					12122	1.65E-4		
							6523	3.32E-4		
GS-11	14031	3.87E-5			7956	3.49E-5	17265	4.78E-5	17412	5.46E-5
	5775	1.16E-4					11678	1.04E-4		
							4107	9.23E-5		
GS-12	8046	2.81E-4			15123	5.07E-5			14719	7.37E-5
	21071	5.14E-4			4790	4.85E-5				
	5712	1.24E-4								
GS-13	17415	7.58E-5			13565	5.88E-5	17870	2.80E-4	15070	9.67E-5
	5915	4.52E-4			4798	5.97E-5	9024	4.52E-4		
							5494	4.97E-4		
GS-15	20057	7.64E-5			12079	2.57E-5	19629	5.64E-5	17111	6.60E-5
	6225	8.59E-5					10289	9.07E-5		
							6052	1.16E-4		
GS-M1	7800	3.68E-5			6408	4.33E-5	13283	3.89E-5	19483	5.19E-5
							10005	4.72E-5		
							6286	6.45E-5		
GS-M4	8304	2.93E-5			7137	1.10E-4	15172	7.44E-5		
							8293	7.82E-5		
GS-D16							14260	1.42E-4		
GS-D17	16375	4.9E-5					12176	3.76E-5	13023	5.12E-5
	7040	4.7E-5					9321	4.82E-5		
							6553	6.82E-5		
TO-1	10477	1.13E-4			11336	3.64E-5	5300	3.77E-2	14576	1.66E-3
	1134	1.04E-4			6520	5.36E-5	9235	1.10E-2	10171	5.63E-3
							5233	6.58E-2		
TO-2	24045	3.95E-5	5807	3.71E-4	5657	5.84E-4	17077	3.93E-5	11759	4.76E-5
	7220	4.37E-5			8935	1.20E-5	10773	4.99E-5		
					4220	4.04E-3	6700	7.53E-5		

TABLE 1.2-13

TRANSMISSIVITY & COEFFICIENT OF STORAGE
FROM
LOWER AQUIFER RECOVERY TEST

Observation Hole	GS-D16 174 gpm		GS-D17 275 gpm		GS-D17 275 gpm		GS-D19 667 gpm		GS-D19 667 gpm	
	T	S	T	S	T	S	T	S	T	S
AM-2A					46931	1.42E-4	32694	4.01E-5	29344	1.44E-4
AM-3							34389	6.08E-5	48274 30568	2.20E-4 2.50E-4
CE-702					61477	5.16E-5	2902 6723 14693	4.09E-5 3.28E-6 3.79E-10	30114	7.25E-5
CE-707	48873	8.45E-6	13502	9.90E-5	11260	5.73E-5	15784	3.50E-5	17372	8.16E-5
CE-708	36173	4.90E-6	27784	5.78E-4	21084	5.64E-5	18024	4.29E-5	20170	1.38E-4
CE-709	68840	3.79E-5	28052	1.51E-4	17931	5.66E-5	16920	7.15E-5	18226	1.06E-4
GS-1			14827	1.43E-4	10205 33509	8.71E-5 3.57E-7	26885	4.92E-5	26874	1.13E-4
GS-2-3	88655	2.63E-6	10379 25921	2.23E-4 3.29E-5	11338	8.96E-5	15528	5.03E-5	17943	6.53E-5
GS-4-5	135333	1.25E-5	51931	1.08E-2	25961	6.59E-5				
GS-6					29735	9.29E-5	20338	1.16E-4	26220	8.59E-5
GS-8	50932	2.66E-5			14349	4.86E-5	17193	2.53E-5	16594	7.19E-5
GS-9	32329	1.21E-5			14078	6.05E-5	18291	6.93E-5	18922	2.95E-4
GS-10					14844	6.59E-5	22261	6.78E-5	25531	1.02E-4
GS-11	20082	6.05E-6			20344	9.81E-5	33516	2.93E-5	25284	1.04E-4
GS-12	6622 19967 32751	1.81E-4 1.20E-4 7.16E-7	6363	2.30E-5	48819	2.95E-5	28187	3.33E-5	24494	9.70E-5
GS-13			6516	3.04E-5	35204	2.61E-5	25396	3.30E-5	21547	1.10E-4
GS-15							35075	4.36E-5	73282 28166	1.32E-4 1.28E-4
GS-M1					6939	4.71E-5	24120	3.70E-5	18264	7.76E-5
GS-M4							33820	1.35E-4	36986	3.49E-4
GS-D17	63363	4.95E-5	6854				15603	3.72E-5	16162	8.01E-5
GS-D19									20170	1.38E-4
TO-1					21722	6.39E-5	14942	5.82E-5	14780 17743	1.89E-3 6.68E-4
TO-2	61872	4.93E-5	8498	7.44E-5	7205	1.65E-4	16042	4.12E-5	16894	7.22E-5

RBOSP PROGRESS REPORT

the pumping test of G-S D18 was conducted simultaneously with the pumping of G-S D19 so that the water could be mixed to meet water quality discharge requirements. No values of T or S were calculated for the drawdown during pumping due to the effects of G-S D19 that was started the previous day. G-S D19 was shut down five days into the test due to mechanical failure, but G-S D18 was continued since water quality was by then below the maximum limit of 5000 umhos/cm conductivity set by the oil shale supervisor. The recovery data for G-S D18 is affected by recovery of G-S D19.

The average T and S during the pumping of lower aquifer G-S D19 were 7041 gpd/foot and 1.78×10^{-4} respectively. The values of G-S D19 pumping from 5/20/75 to 5/26/75 cannot be considered accurate due to the simultaneous pumping of G-S D18.

Geophysical well logs were run in G-S 12 and TO 1 during pumping tests to determine the lower aquifer nature on a foot-by-foot basis. These logs included: temperature, acoustic flow, and radio-active tracer surveys. During the pumping of G-S D16 a radio-active tracer was run in G-S 12. The interpretation of this log is inconclusive as to where water may be flowing through the bore hole. During the pumping of G-S D19, all three of the above-mentioned logs were run.

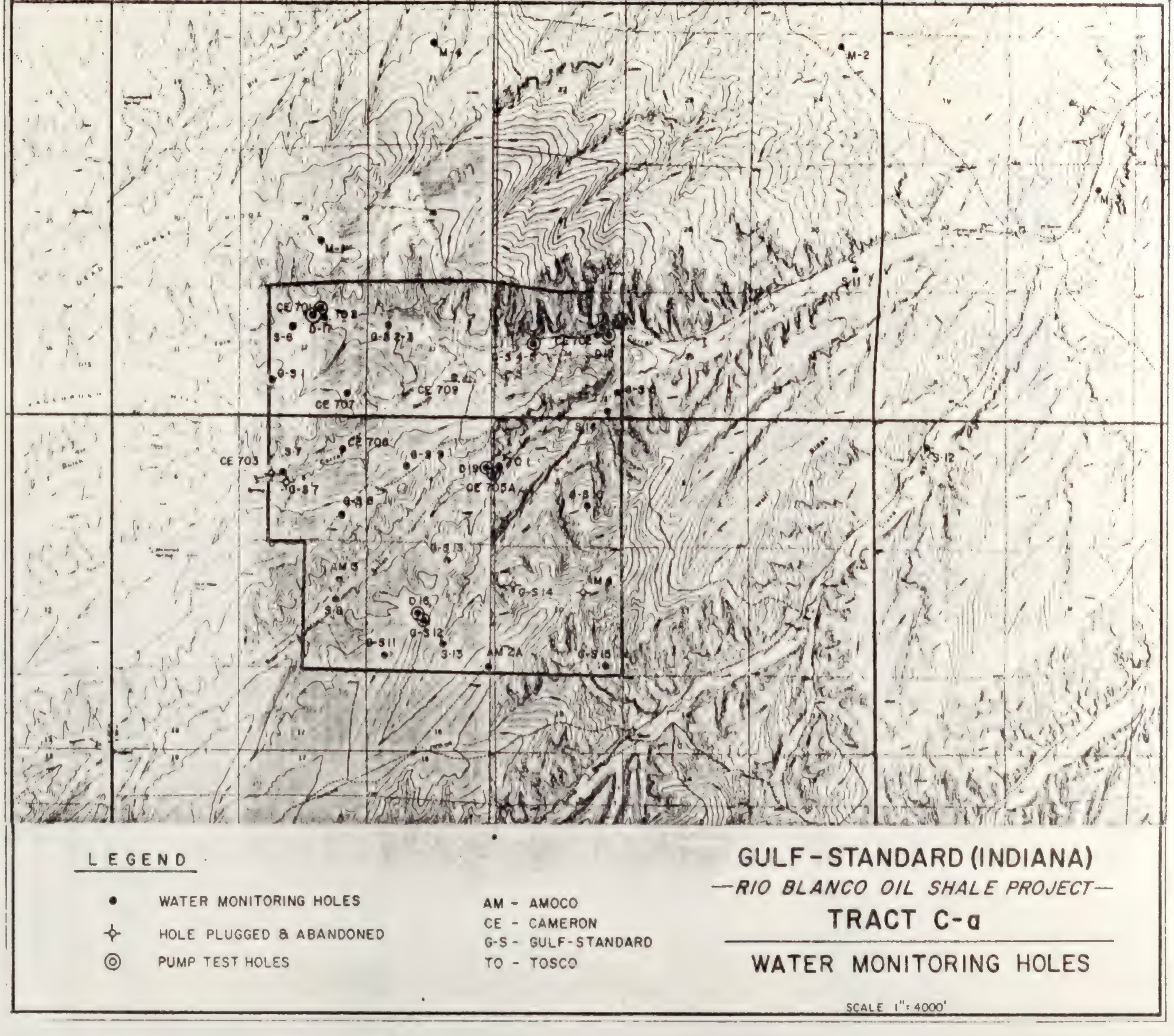
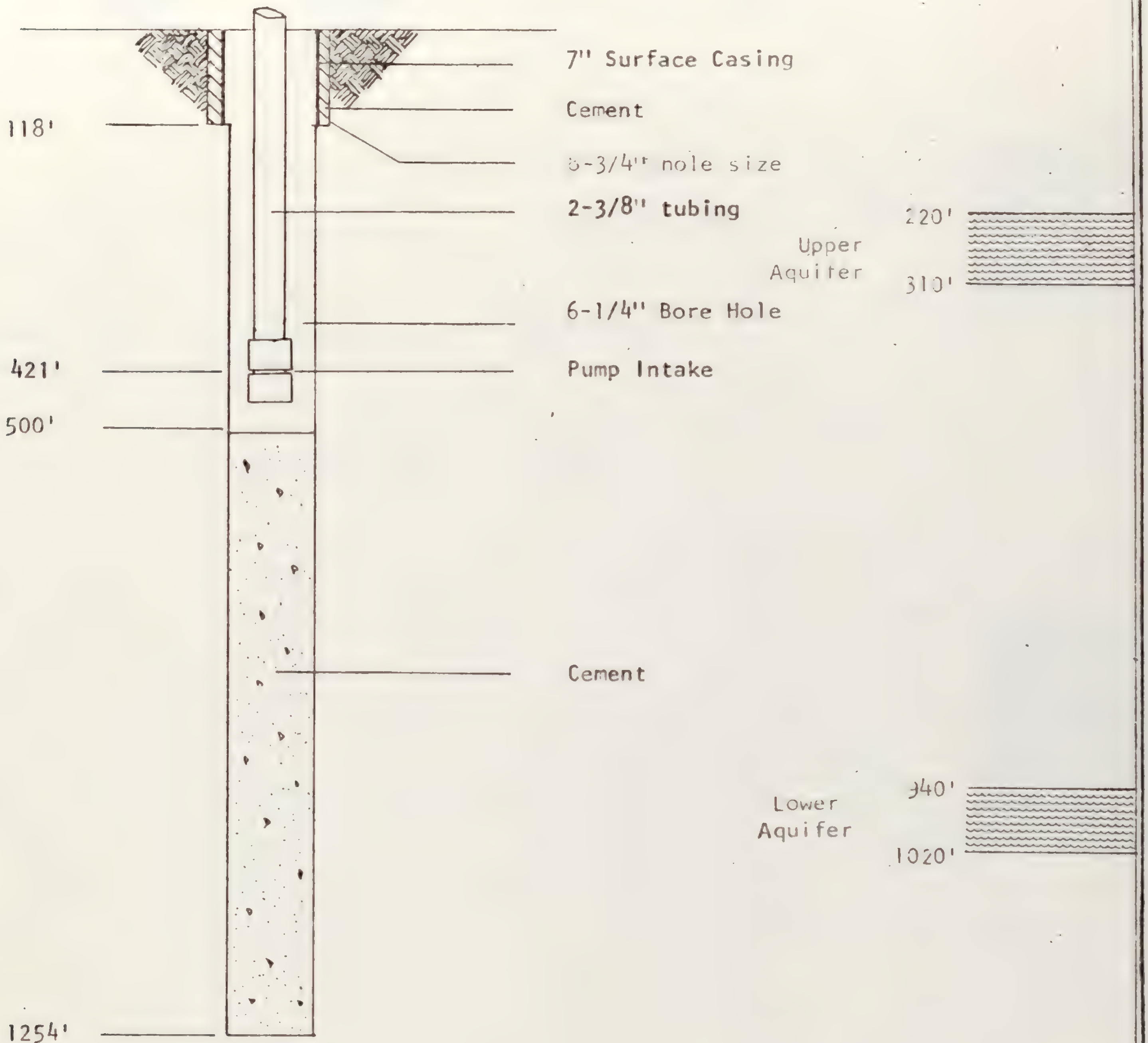

GULF-STANDARD (INDIANA)
—RIO BLANCO OIL SHALE PROJECT—
TRACT C-a
WATER MONITORING HOLES
SCALE 1" = 4000'
LEGEND
● WATER MONITORING HOLES
⌖ HOLE PLUGGED & ABANDONED
◎ PUMP TEST HOLES
AM - AMOCO
CE - CAMERON
G-S - GULF-STANDARD
TO - TOSCO
M-1
M-2
M-3
M-4
S-11
S-12
CE 701
D-17
S-6
G-S 1
CE 707
CE 709
CE 702
D-11
CE 706
CE 703
S-7
G-S 7
G-S 8
D-19
CE 705A
S-13
AM 5
S-8
D-16
G-S 12
G-S 11
AM 2A
G-S 14
AM 4
G-S 16

Figure 1.2-19

PUMP INSTALLATION

15 HP



RBOSP PROGRESS REPORT

RIO BLANCO
OIL SHALE PROJECT

HOLE CE-701 DEPTH 1254

FEBRUARY 1975

WRIGHT WATER ENGINEERS INC
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER COLORADO 8021.

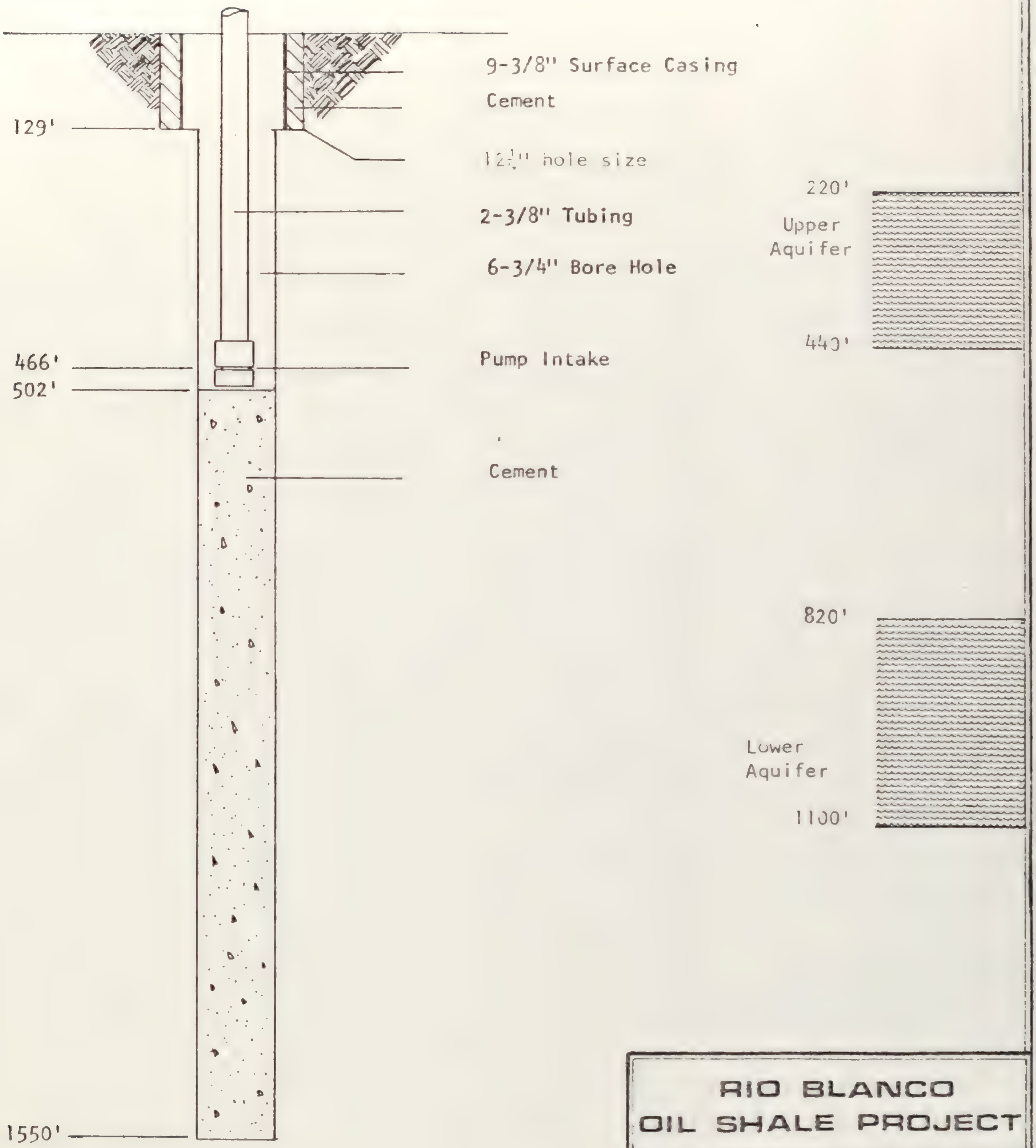
VERITICAL SCALE 1"-200'

HORIZONTAL SCALE 1"-1'-0"

FIG. 1.2-20

PUMP INSTALLATION

15 HP



RIO BLANCO
OIL SHALE PROJECT

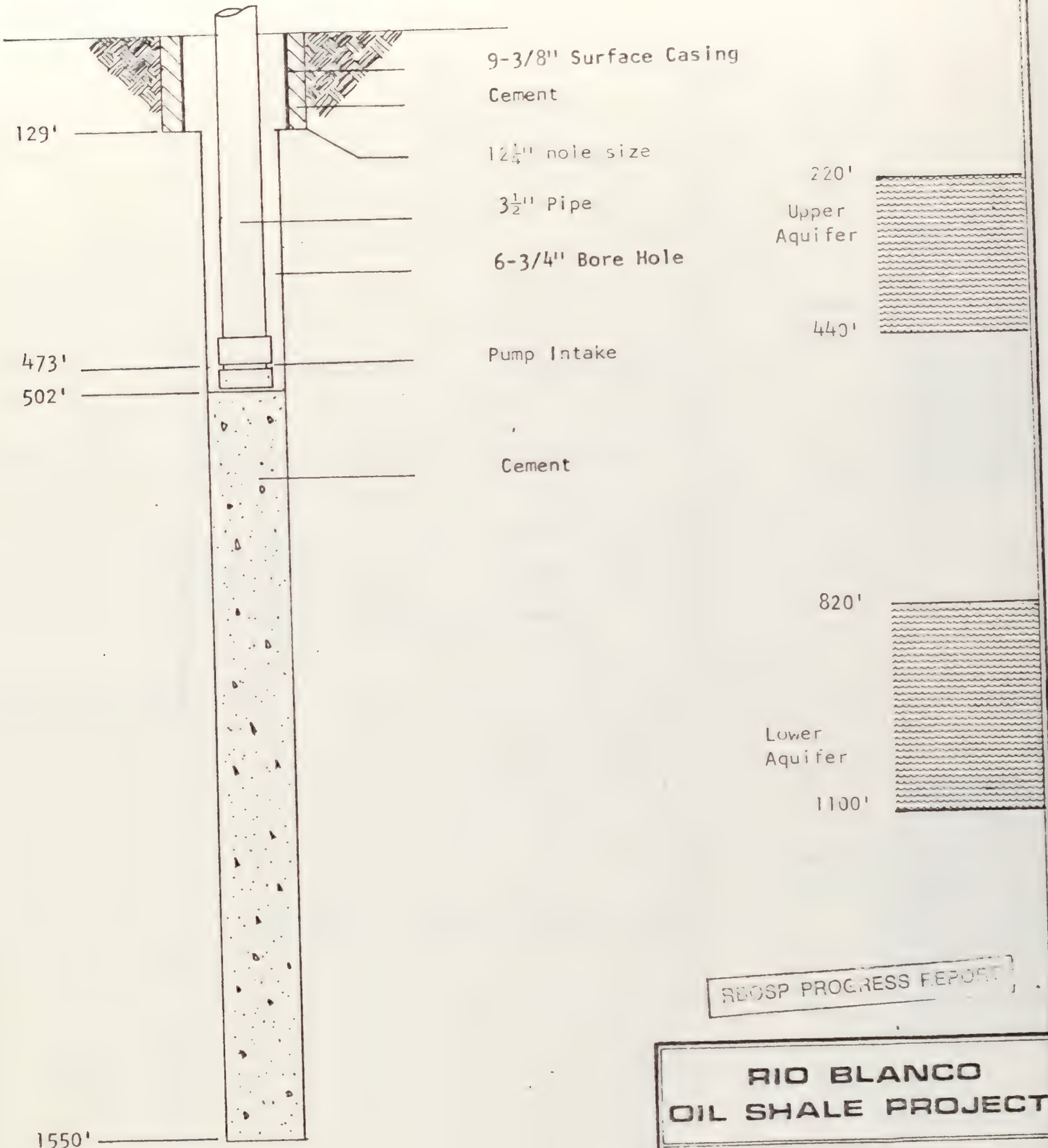
HOLE CE-705A DEPTH 1550
FEBRUARY 1975

WRIGHT WATER ENGINEERS INC
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER COLORADO 80211

VERITICAL SCALE 1"-200'
HORIZONTAL SCALE 1"-1'-0"

FIG. 1.2-2

PUMP INSTALLATION
60 HP



RBOSP PROGRESS REPORT

**RIO BLANCO
OIL SHALE PROJECT**

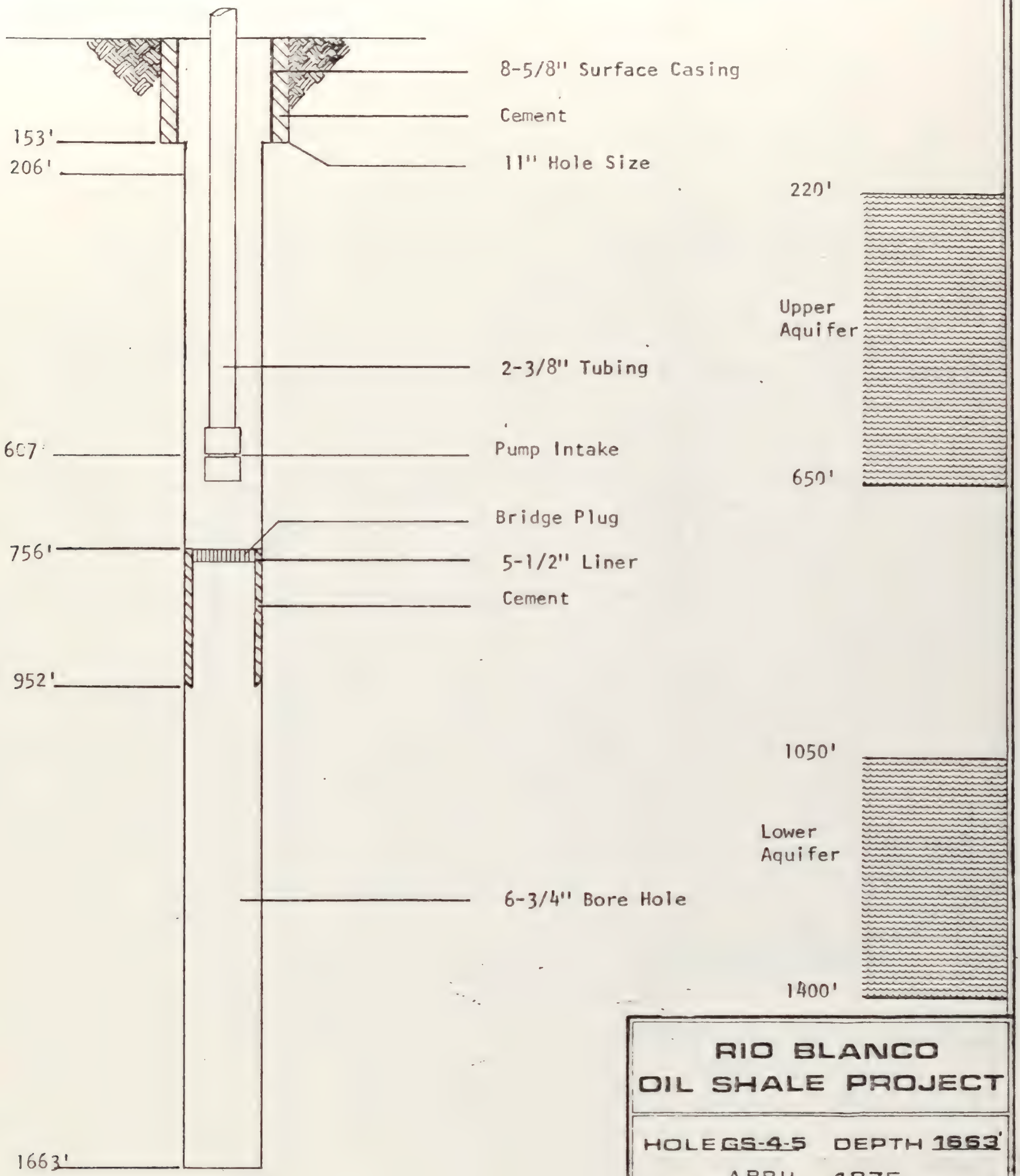
HOLE CE-705A DEPTH 1550
MARCH 1975

WRIGHT WATER ENGINEERS INC
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER COLORADO 80211

VERITICAL SCALE 1"-200'
HORIZONTAL SCALE 1"-1'-0"

PUMP INSTALLATION

15 HP



RIO BLANCO
OIL SHALE PROJECT

HOLE GS-4-5 DEPTH 1663'

APRIL 1975

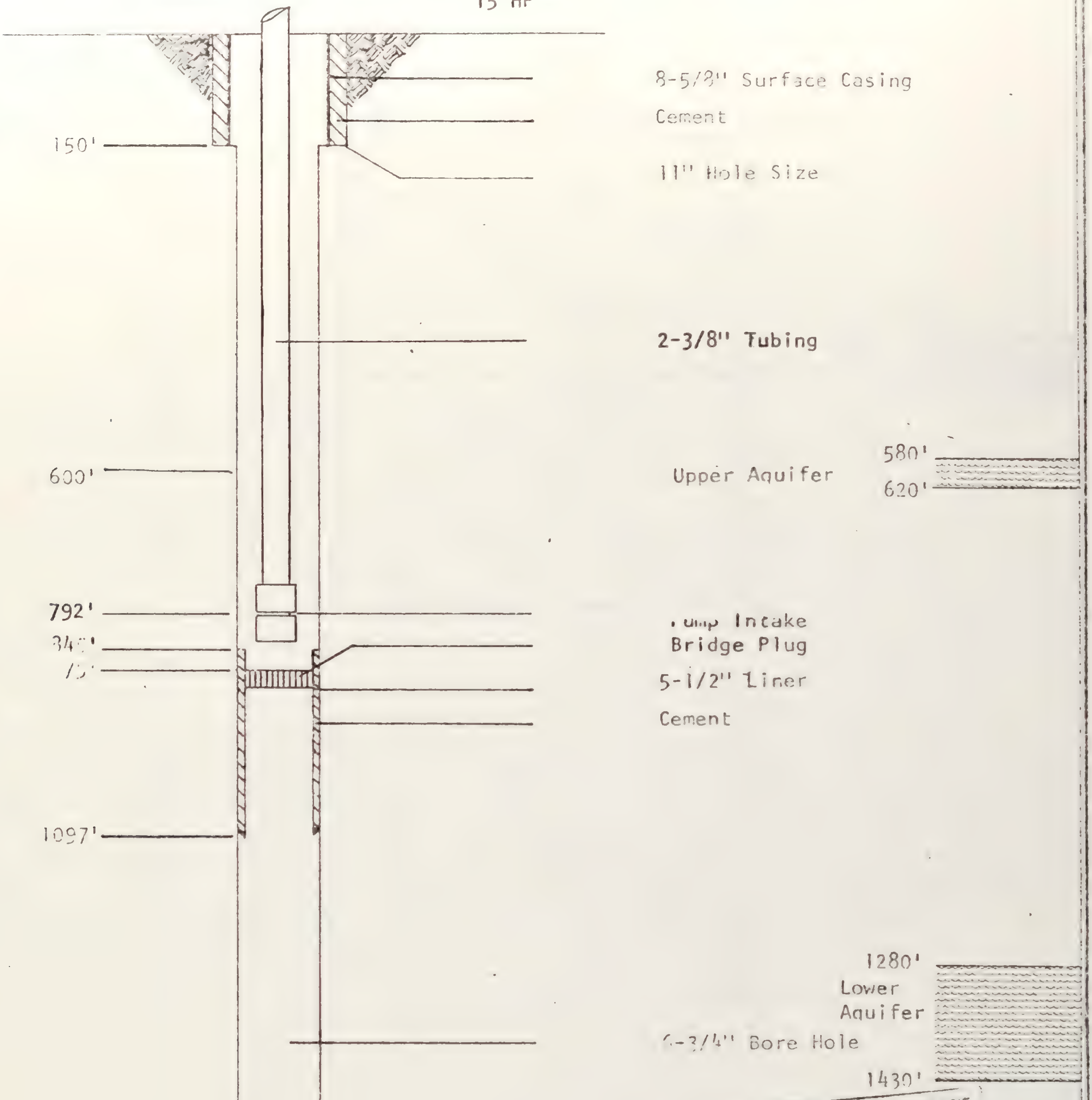
WRIGHT WATER ENGINEERS INC
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER COLORADO 80211

VERTICAL SCALE 1" - 200'

HORIZONTAL SCALE 1" - 1'-0"

Figure 1.2-23

PUMP INSTALLATION
15 HP



PROGRESS REPORT

RIO BLANCO
OIL SHALE PROJECT

HOLE GS-12 DEPTH 1800'
MARCH 1975

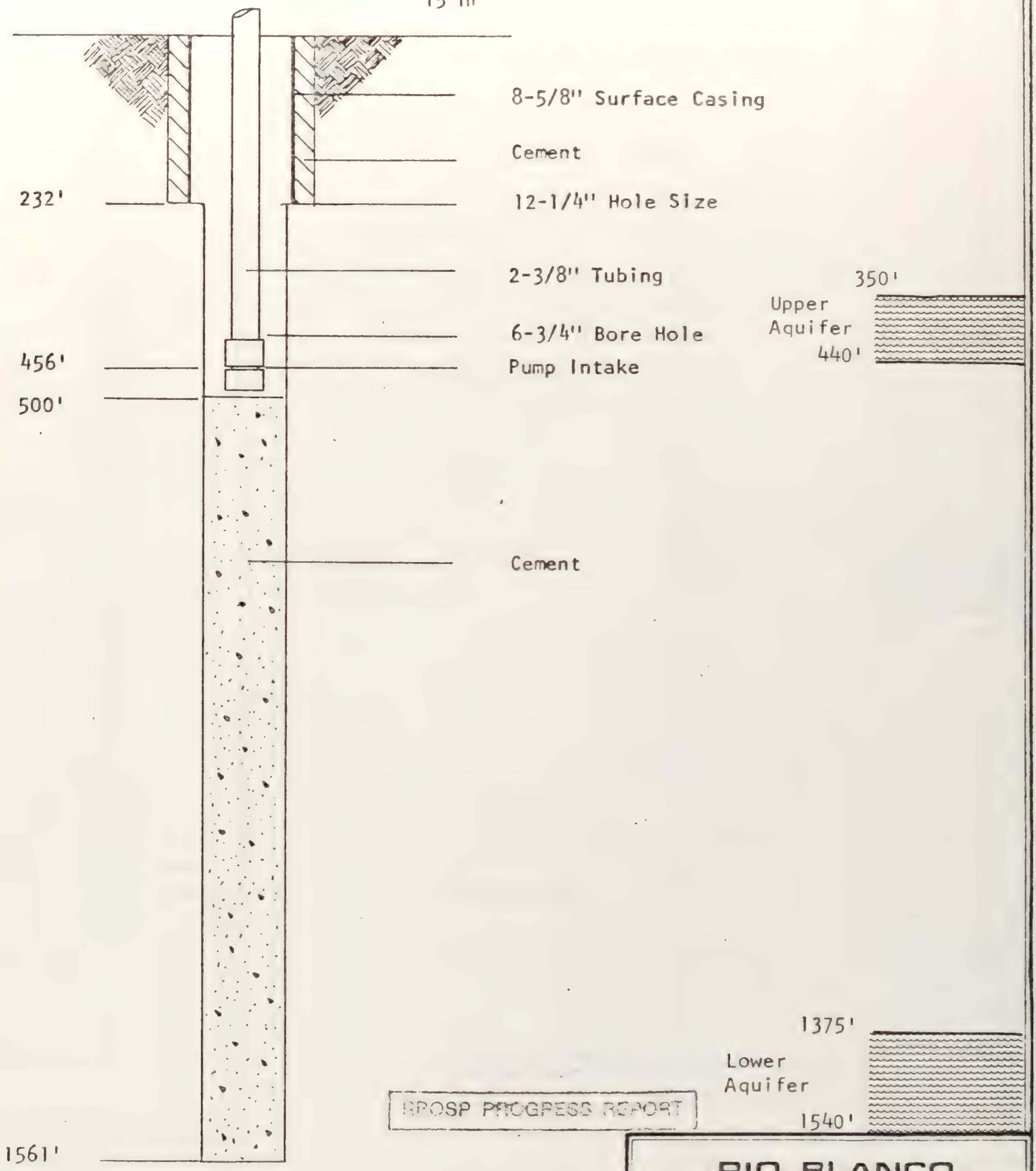
WRIGHT WATER ENGINEERS INC.
ENGINEERING CONSULTANTS
[illegible]
DENVER COLORADO

VERITICAL SCALE 1"-200'
HORIZONTAL SCALE 1"-1'-0"

FIG.1.2-24

PUMP INSTALLATION

15 HP



RBOSP PROGRESS REPORT

RIO BLANCO
OIL SHALE PROJECT

HOLE TQ-3 DEPTH 1561
JANUARY 1975

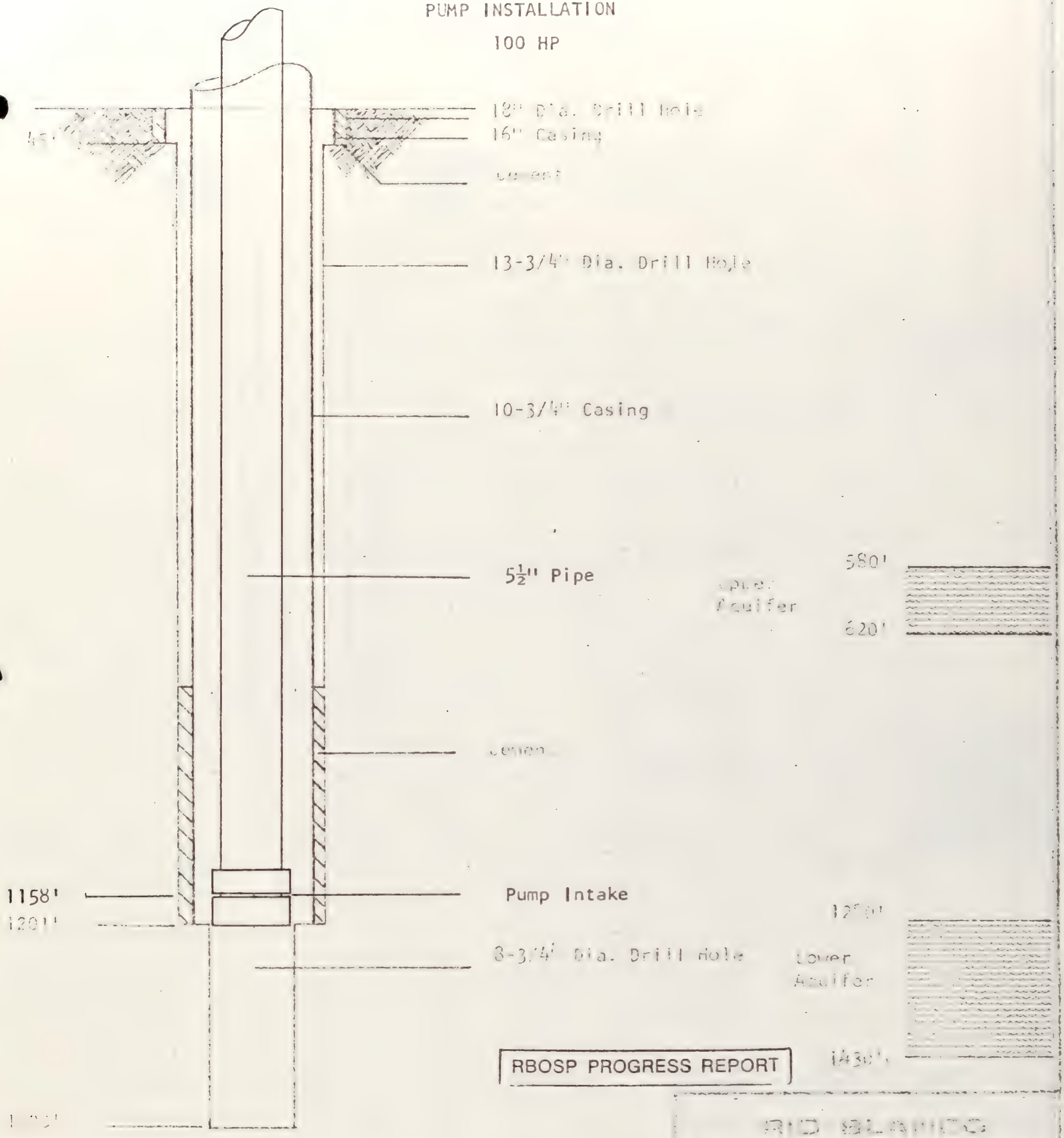
WRIGHT WATER ENGINEERS INC
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER COLORADO 80211

VERITICAL SCALE 1"-200'
HORIZONTAL SCALE 1"-1'0"

FIG. 1.2-25

PUMP INSTALLATION

100 HP



RBOSP PROGRESS REPORT

RIO BLANCO
OIL SHALE PROJECT

GS-D-16 1500

FEBRUARY 1975

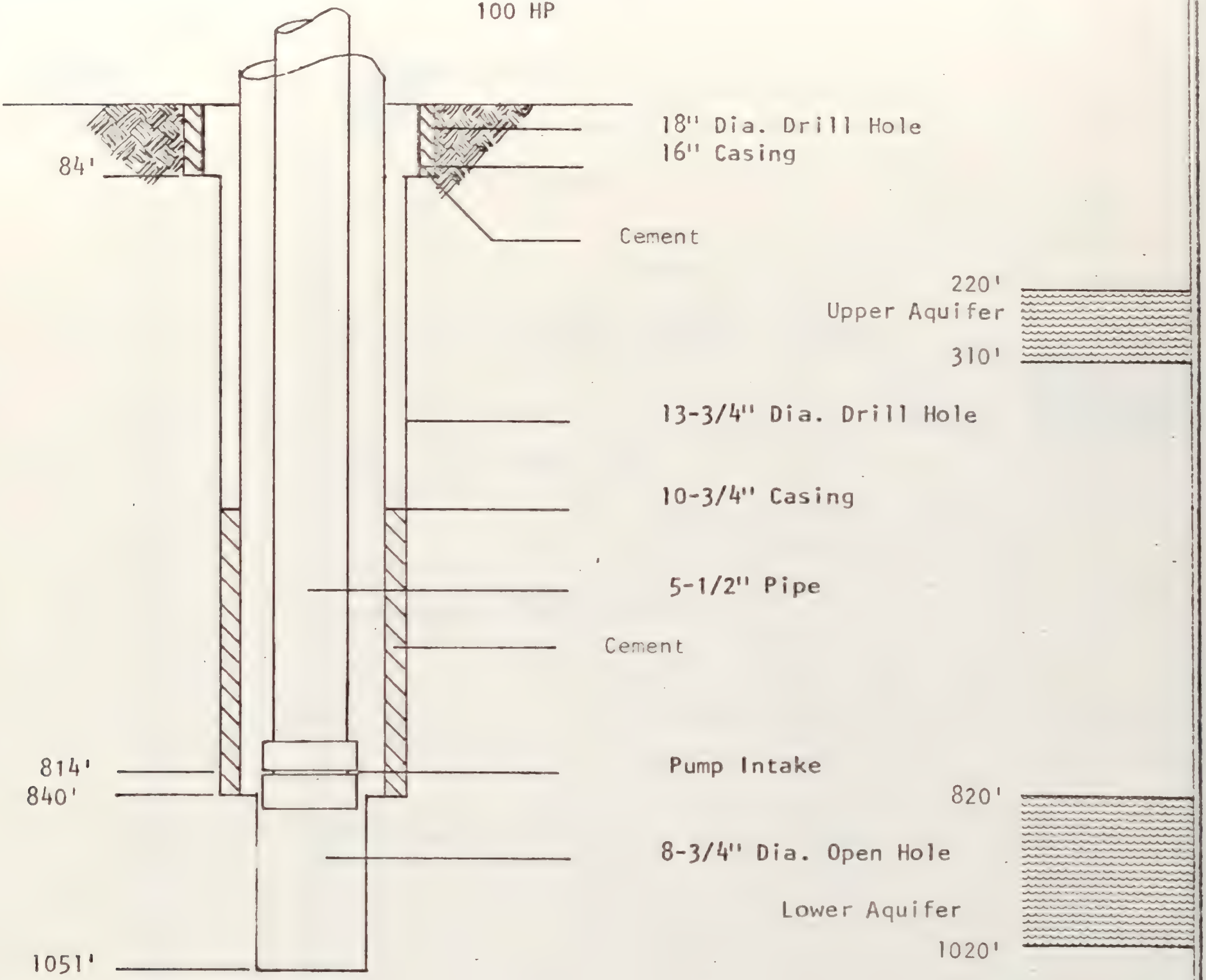
1"=200'

1'-1-0"

FIG 1.2-26

PUMP INSTALLATION

100 HP



RBOSP PROGRESS REPORT

RIO BLANCO
OIL SHALE PROJECT

HOLE GS-D-17 DEPTH 1051

JANUARY 1975

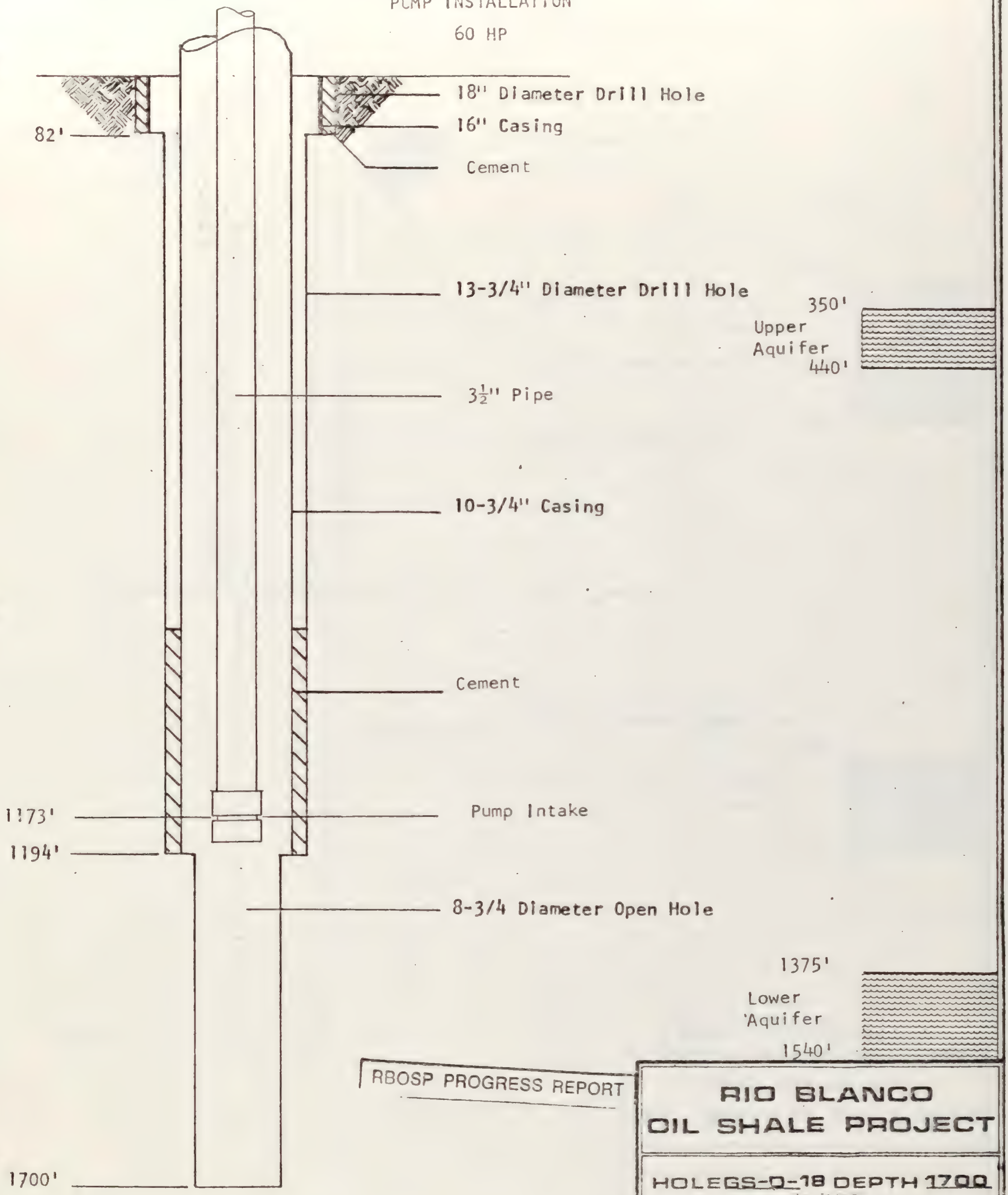
WRIGHT WATER ENGINEERS INC
ENGINEERING CONSULTANTS
3420 [illegible] STREET
DENVER COLORADO [illegible]

VERITICAL SCALE 1"-200'
HORIZONTAL SCALE 1"-1'-0"

Figure 1.2-27

PUMP INSTALLATION

60 HP



RBOSP PROGRESS REPORT

RIO BLANCO
OIL SHALE PROJECT

HOLE GS-D-18 DEPTH 1700

APRIL 1975

WRIGHT WATER ENGINEERS INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER COLORADO 80211

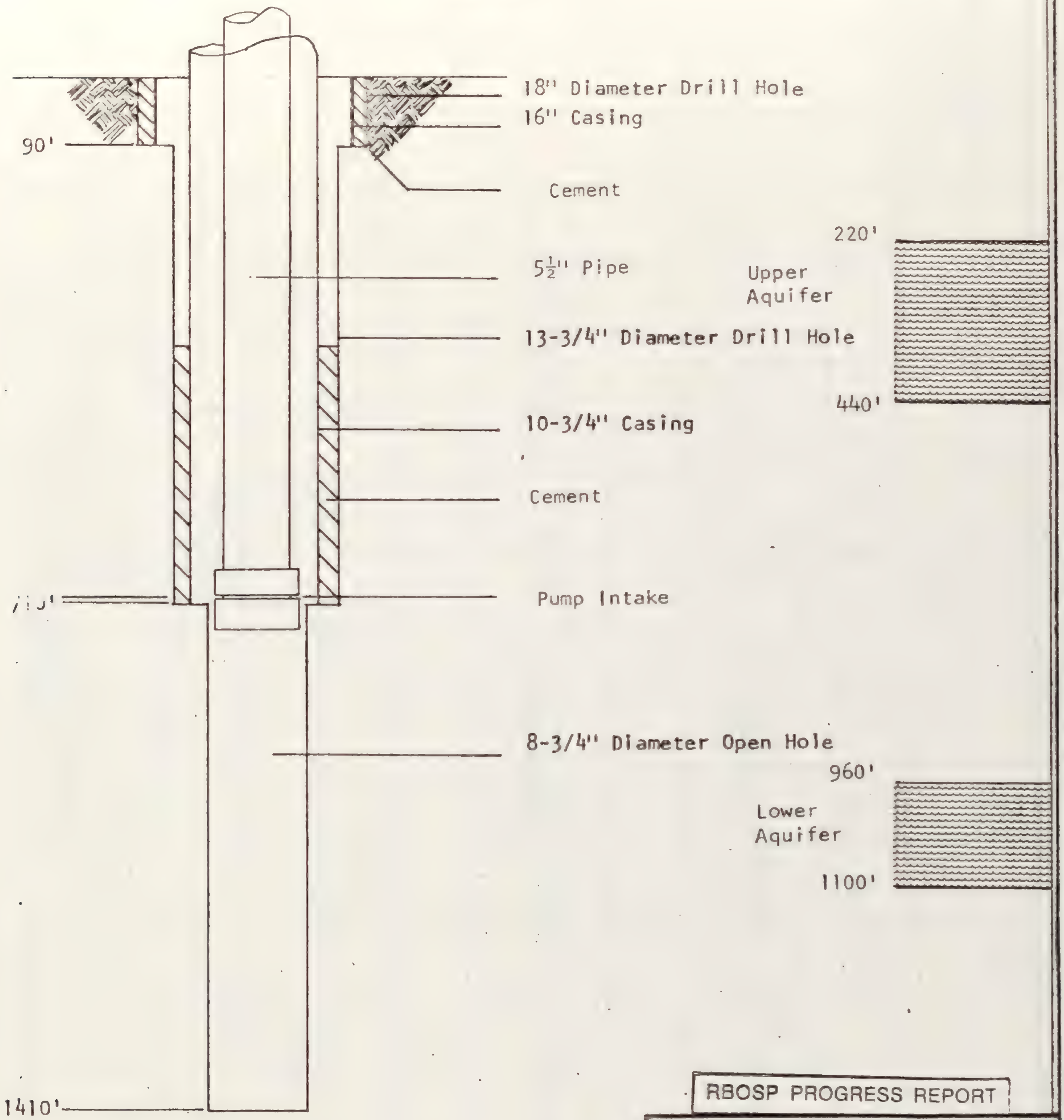
VERITICAL SCALE 1"-200'

HORIZONTAL SCALE 1"-1'-0"

1.2-28

PUMP INSTALLATION

260 HP



RBOSP PROGRESS REPORT

RIO BLANCO
OIL SHALE PROJECT

HOLE GS-D-19 DEPTH 1410

JANUARY 1975

WRIGHT WATER ENGINEERS, INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211

VERITICAL SCALE 1"-200'

HORIZONTAL SCALE 1"-1'-0"

FIG. 1.2-29

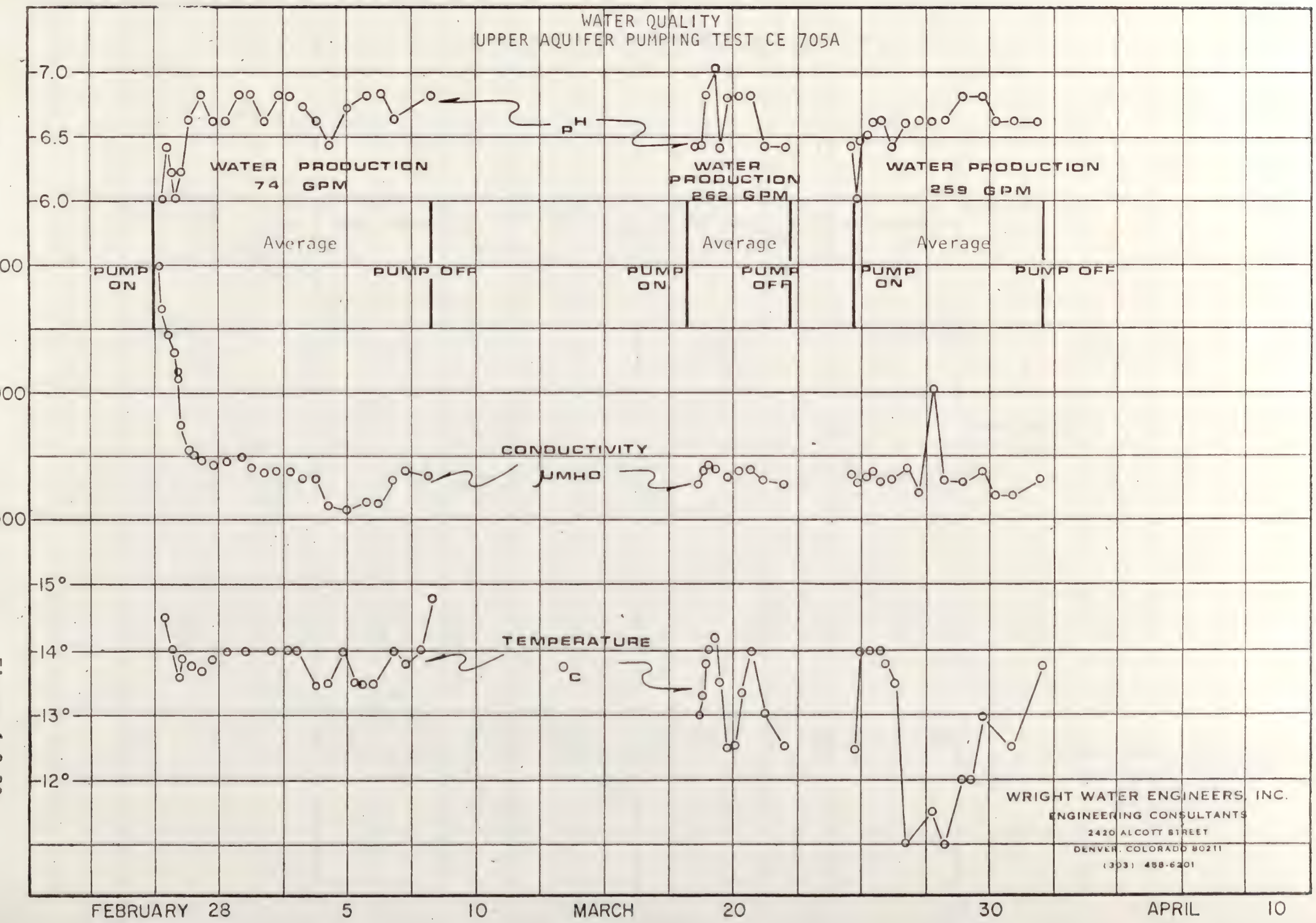
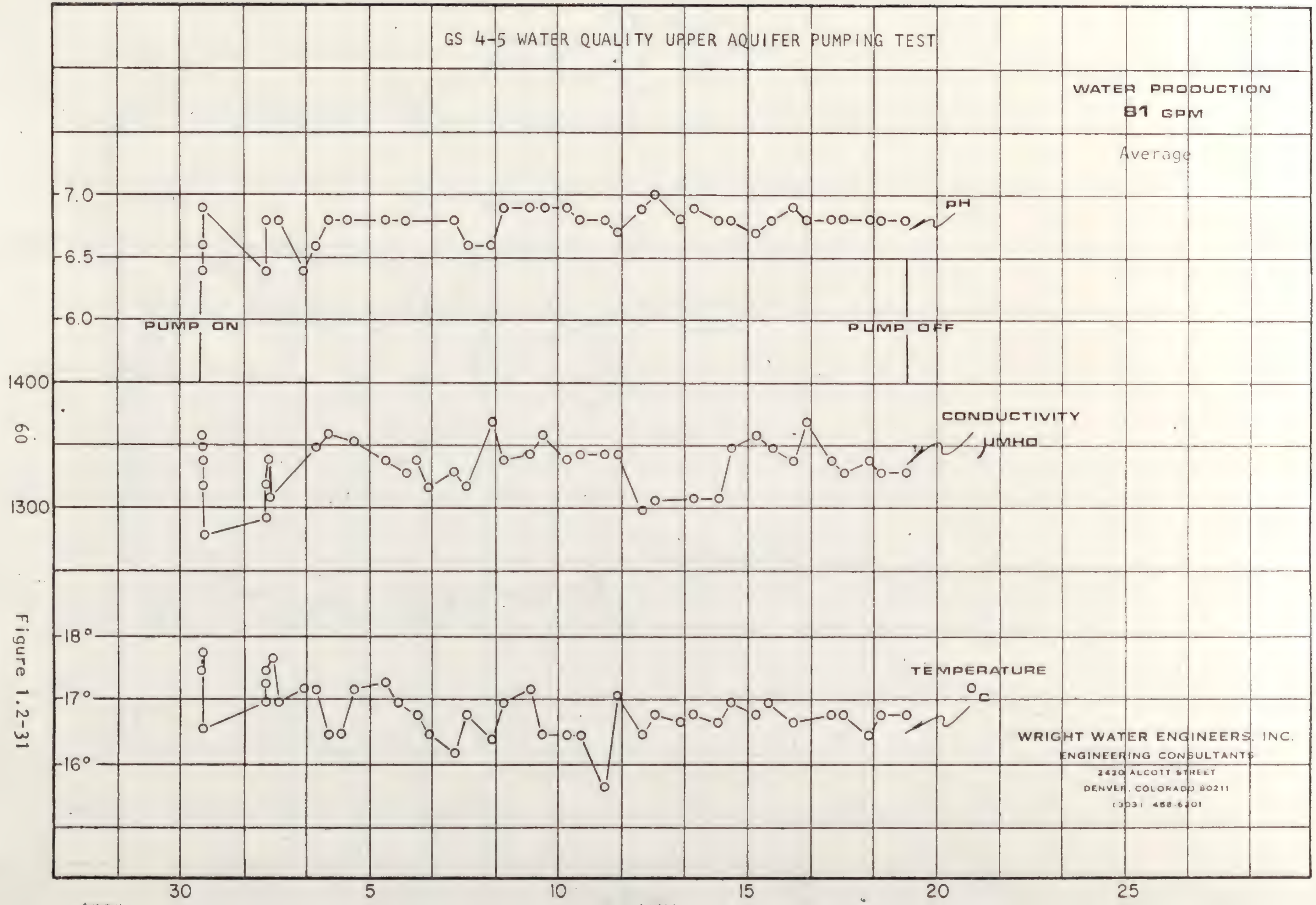

WATER QUALITY
UPPER AQUIFER PUMPING TEST CE 705A
7.0
6.5
6.0
000
2000
1000
15°
14°
13°
12°
pH
WATER PRODUCTION 74 GPM
WATER PRODUCTION 262 GPM
WATER PRODUCTION 259 GPM
Average
Average
Average
PUMP ON
PUMP OFF
PUMP ON
PUMP OFF
PUMP ON
PUMP OFF
CONDUCTIVITY
μMHO
TEMPERATURE
°C
FEBRUARY 28
5
10
MARCH
20
30
APRIL
10
WRIGHT WATER ENGINEERS, INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211
(303) 458-6201

Figure 1.2-30


GS 4-5 WATER QUALITY UPPER AQUIFER PUMPING TEST

WRIGHT WATER ENGINEERS, INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211
(303) 458-6201

Figure 1.2-31

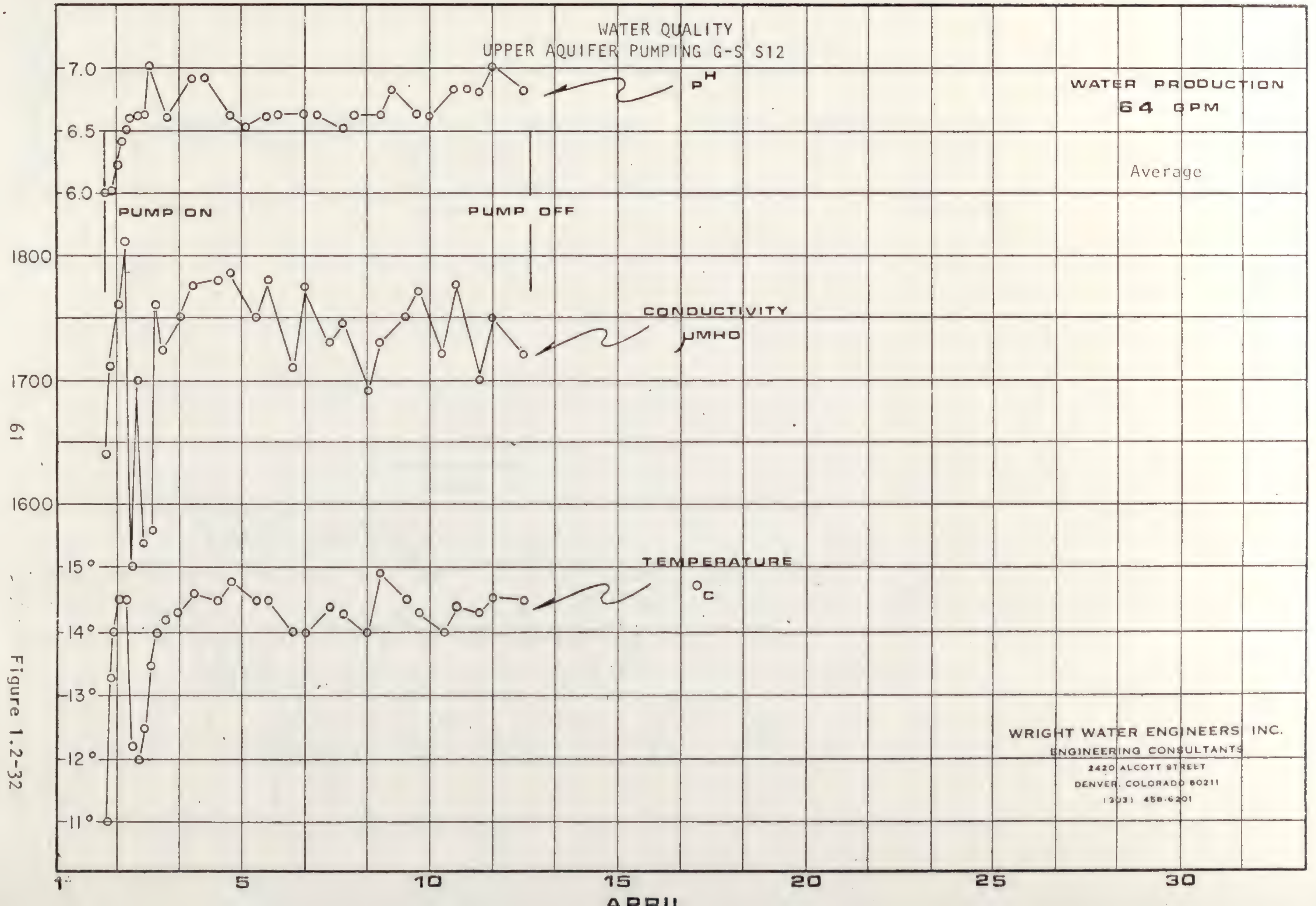

WATER QUALITY
UPPER AQUIFER PUMPING G-S S12
pH
CONDUCTIVITY
μMHO
TEMPERATURE
°C
PUMP ON
PUMP OFF
WATER PRODUCTION
64 GPM
Average
7.0
6.5
6.0
1800
1700
1600
15°
14°
13°
12°
11°
1
5
10
15
20
25
30
APRIL
WRIGHT WATER ENGINEERS INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211
(303) 458-6201

Figure 1.2-32

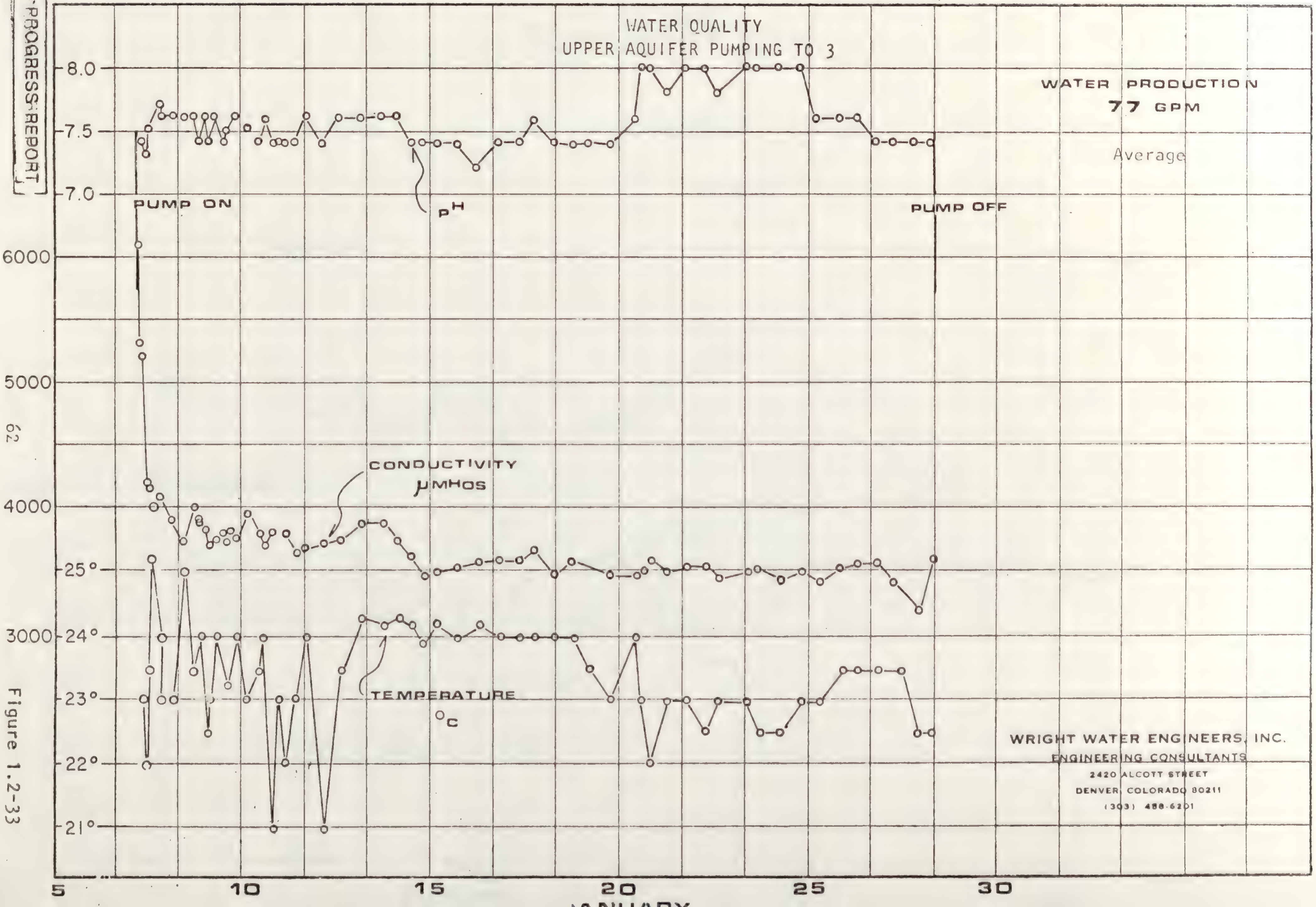

WATER QUALITY
UPPER AQUIFER PUMPING TO 3
WATER PRODUCTION
77 GPM
Average
8.0
7.5
7.0
6000
5000
4000
3000
25°
24°
23°
22°
21°
PUMP ON
PUMP OFF
pH
CONDUCTIVITY
μMHOS
TEMPERATURE
°C
5
10
15
20
25
30
WRIGHT WATER ENGINEERS, INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211
(303) 488-6201

Figure 1.2-33

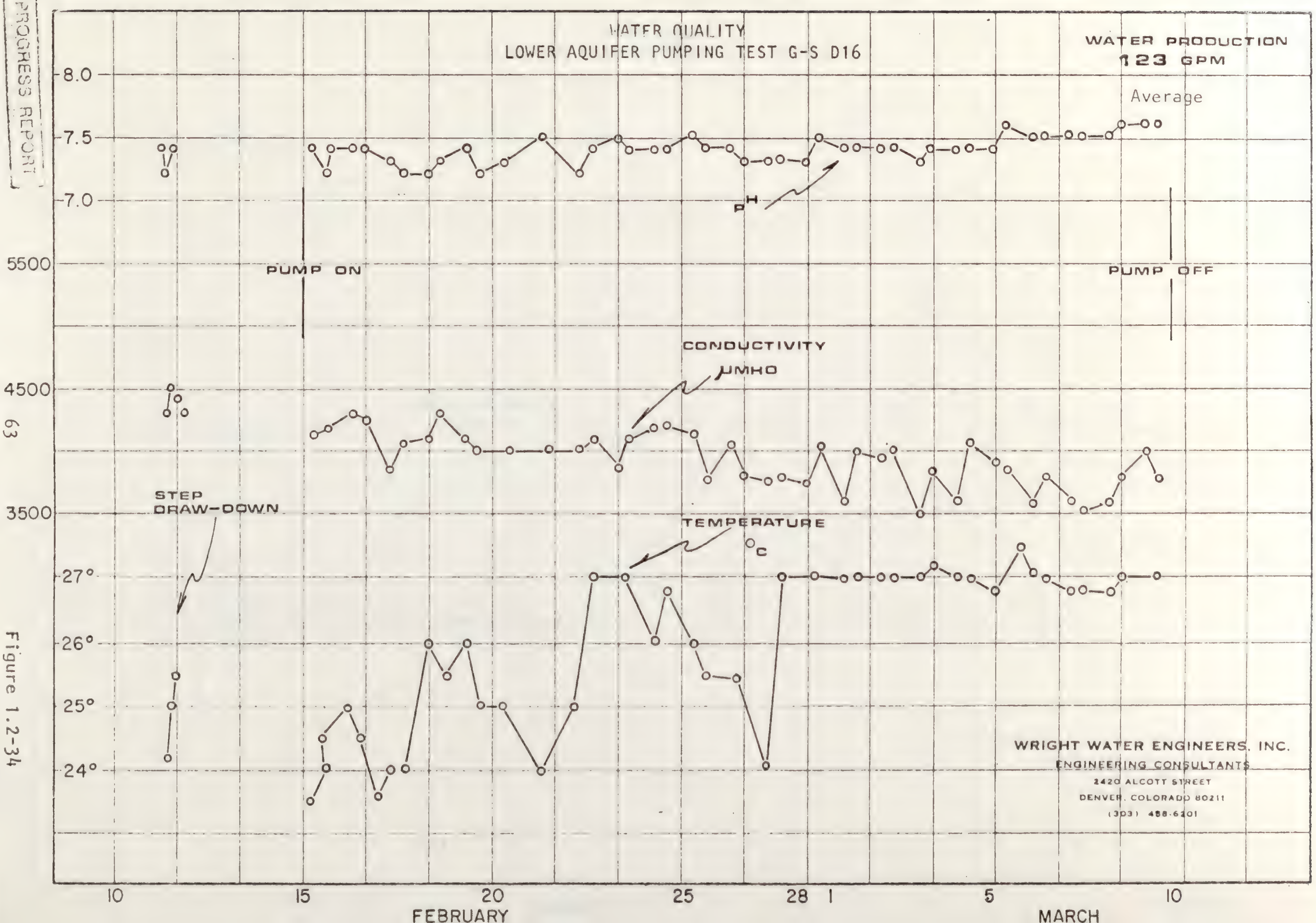
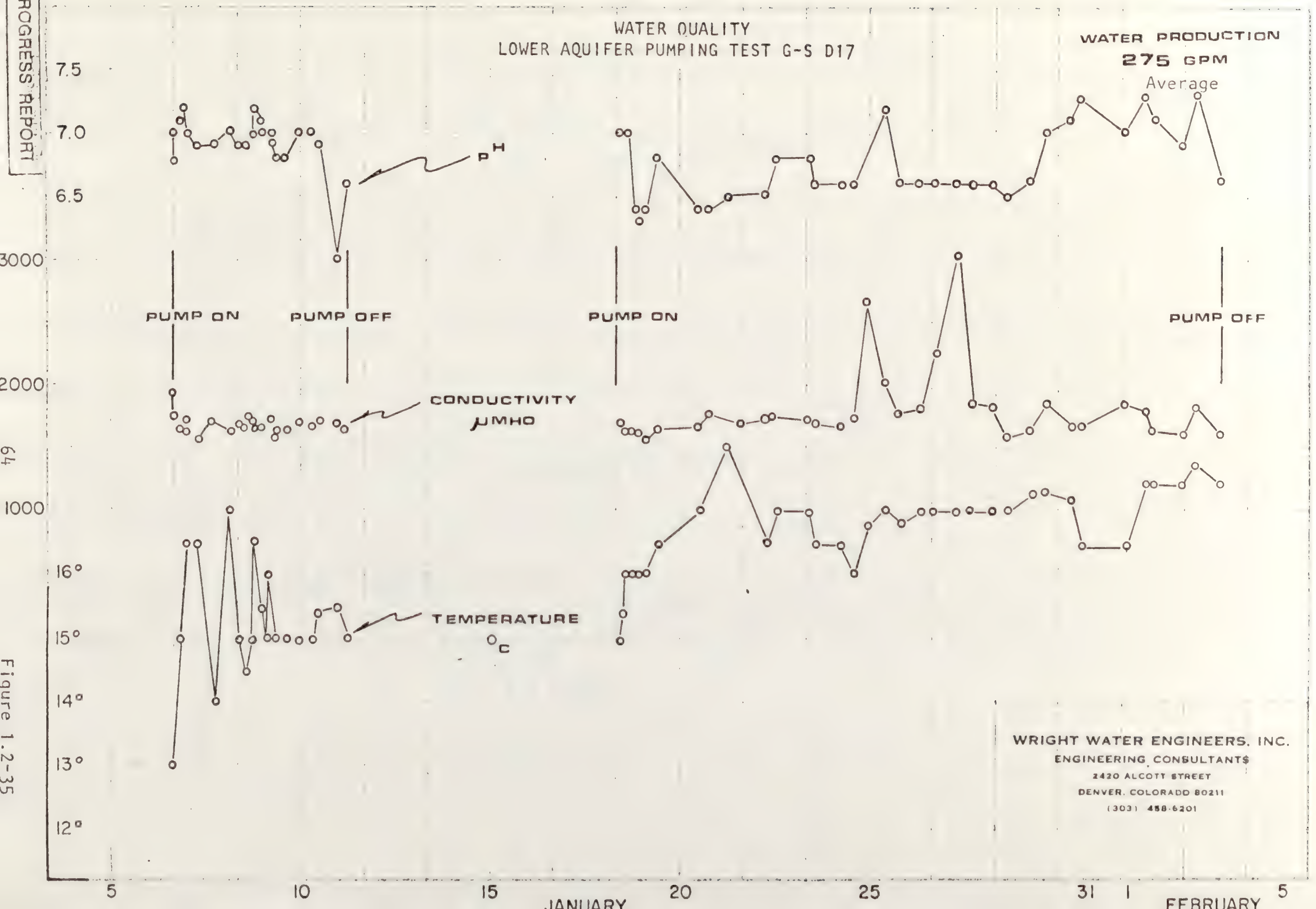

WATER QUALITY
LOWER AQUIFER PUMPING TEST G-S D16
WATER PRODUCTION
123 GPM
Average
8.0
7.5
7.0
5500
4500
3500
27°
26°
25°
24°
PUMP ON
PUMP OFF
pH
CONDUCTIVITY
μMHO
STEP
DRAW-DOWN
TEMPERATURE
°C
WRIGHT WATER ENGINEERS, INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211
(303) 488-6201
10
15
20
25
28
1
5
10
FEBRUARY
MARCH

Figure 1.2-34

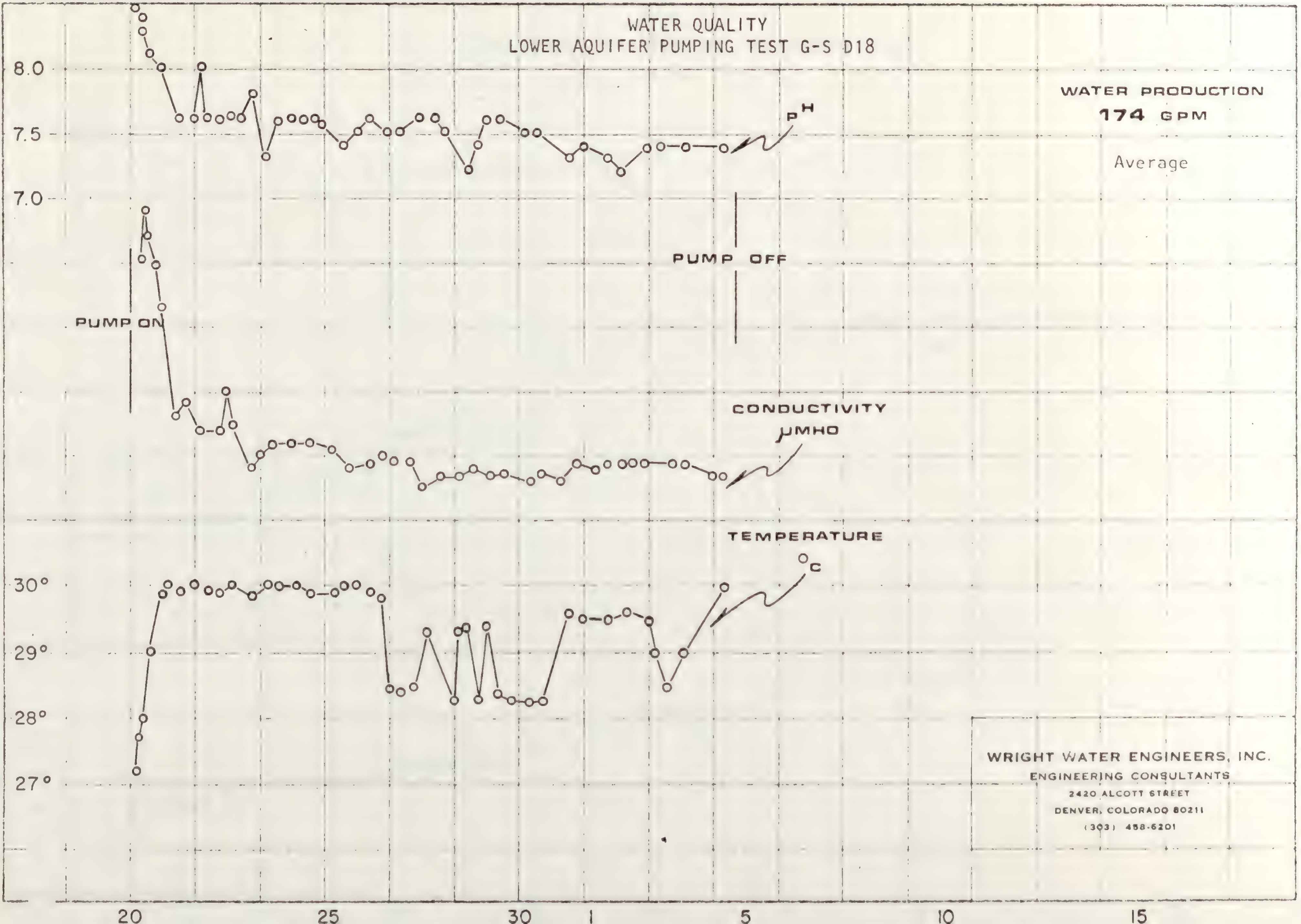


WATER QUALITY
LOWER AQUIFER PUMPING TEST G-S D17

WATER PRODUCTION
275 GPM
Average

WRIGHT WATER ENGINEERS, INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211
(303) 458-6201

Figure 1.2-35



WATER QUALITY
LOWER AQUIFER PUMPING TEST G-S D18

Figure 1.2-36

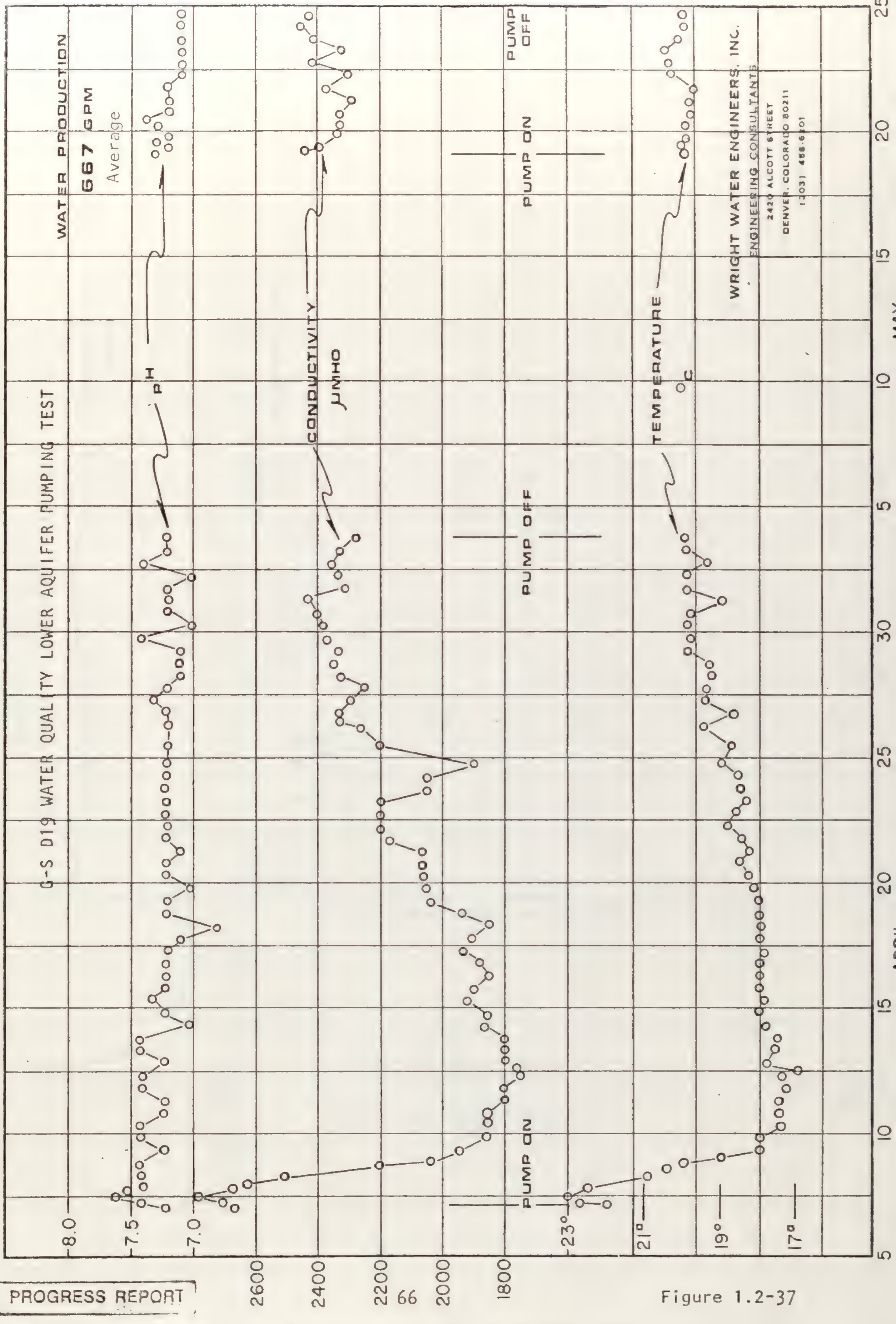

G-S D19 WATER QUALITY LOWER AQUIFER PUMPING TEST
WATER PRODUCTION
667 GPM
Average
pH
CONDUCTIVITY
μMHO
TEMPERATURE
°C
PUMP ON
PUMP OFF
PUMP ON
PUMP OFF
8.0
7.5
7.0
2600
2400
2200
2000
1800
23°
21°
19°
17°
5
10
15
20
25
30
5
10
15
20
25
APRIL
MAY
WRIGHT WATER ENGINEERS, INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211
(303) 458-6201

Figure 1.2-37

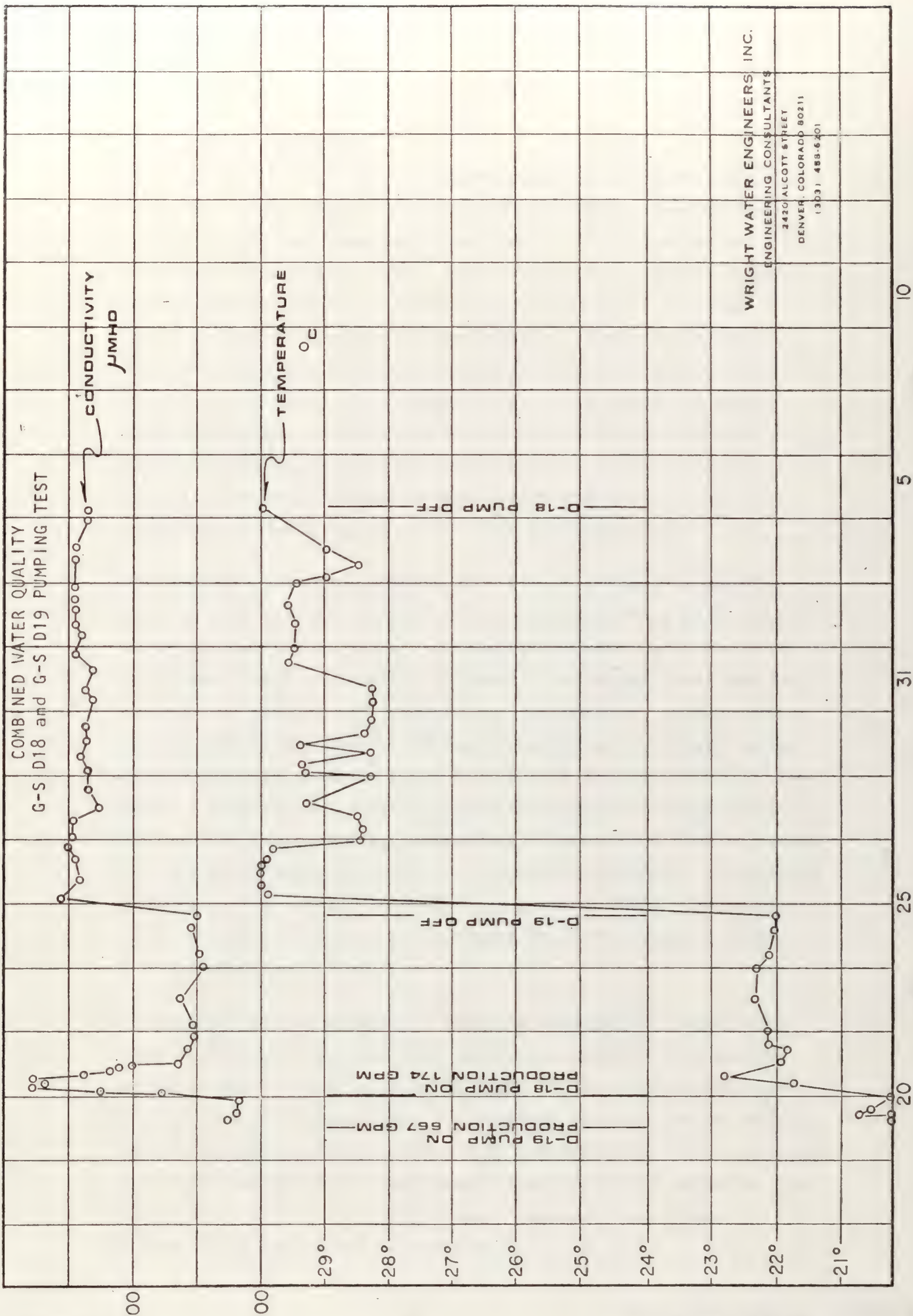

COMBINED WATER QUALITY
G-S D18 and G-S D19 PUMPING TEST
CONDUCTIVITY µMHO
TEMPERATURE °C
D-19 PUMP ON PRODUCTION 667 GPM
D-18 PUMP ON PRODUCTION 174 GPM
D-19 PUMP OFF
D-18 PUMP OFF
4000
2000
29°
28°
27°
26°
25°
24°
23°
22°
21°
20
25
31
5
10
MAY
JUNE
WRIGHT WATER ENGINEERS, INC.
ENGINEERING CONSULTANTS
2420 ALCOTT STREET
DENVER, COLORADO 80211
(303) 458-6201

Figure 1.2-38

1.2.7 DEEP AQUIFER MONITORING

The deep aquifer monitoring program consists of gathering water level and water temperature data, and collecting samples for testing of various chemical constituents. This program was initiated in December, 1974. Water levels were monitored daily on all the observation monitor holes using wire-line water-level indicators during the pump testing. These water level data are entitled "Hydrographs" and are included in the appendix of this report. Also, water levels were monitored using continuous pressure recording transducer units in 12 holes. The water quality data are reported on the computer printout sheets under method three in Volume 1, Raw Data. A summary is presented in Table 1.2-15 in Section 1.2.6.

The present monitoring program consists of collecting monthly samples from all deep monitor holes, and monitoring water levels using automatic continuous recording transducer units and wire-line water-level indicators. A special stainless steel sampler is used and samples are analyzed for temperature, conductivity and pH immediately upon withdrawal from the hole. Static water levels are also measured using a wire-line device (Volume 1, Raw Data). Chemical additives are used to preserve samples until delivery to the analyzing laboratory. The results from wet chemical and spectrographic analysis is computer tabulated and printed (Volume 1, Raw Data). An associated summary sheet showing specific constituent ranges and averages is also presented (Table 1.2-9 in Section 1.2.6).

In general, the water quality from the deep aquifer monitoring program follows the results gained during the drilling program. A poorer quality area appears to exist in the northeastern section of the tract by G-S D18. A seasonal spring recharge effect appears to be apparent, in that many holes in both lower and upper aquifers show drops in bicarbonate, alkalinity and magnesium content. Zinc and iron concentrations, however, have tended to increase since initiation of sampling.

1.2.8 DATA INPUT TO A MATHEMATICAL MODEL

A mathematical model has been selected. This model will be used to forecast the dewatering and production rates for various pumping and mining configurations. The data input to the model will come from two sources, the first being information gained from the drilling and pump testing on and around the tract, and the second being the data published for the basin from the USGS. At the present time, the mathematical model is being calibrated using these two sources of data. It is anticipated that by the next quarterly report, information will be available from the mathematical model.

1.2.9 THE DEWATERING ANALYSES

The dewatering analyses resulting from the hydrologic mathematical model will give information on various pumping rates for various mining configurations at various times. It is anticipated that preliminary information will be available for the next quarterly report.

R·100·W
R·99·W
R·98·W
T·1·S
T·2
CATHEDRAL BLUFFS
DEAD HORSE RIDGE
SAGEBRUSH HILL
Big Duck Creek
Duck Creek
Corral Gulch
Box Elder Gulch
Wolf Ridge
Stake Springs
Ryan Gulch
Water Gulch
Airplane Ridge
Calamity Ridge
Little Duck
The Shoulder
Spring
Maverick Spring
M1
M2
M3
M4
CE 701
TO 2
D17
G-S 2-3
TO 3
CE 702
D18
G-S 4-5
G-S 1
CE 707
CE 709
G-S 6
S-4
S-6
S7
CE 708
CE 703
G-S 7
G-S 9
D19
TO 1
CE 705A
G-S 10
G-S 8
G-S 13
AM 3
G-S 14
AM 4
S8
D 16
G-S 12
G-S 11
S13
AM 2A
G-S 15
S1
S10
A

LEGEND

- SHALLOW ALLUVIUM MONITORS
- DEEP PUMP TEST
- DEEP MONITOR HOLES
- CORE HOLES
- AIR QUALITY TOWERS
- STREAM GAGING STATIONS
- HOLE PLUGGED & ABANDONED

AM – Amoco
CE – Cameron
G-S – Gulf-Standard
TO – Tosco

GULF-STANDARD INDIANA
RIO BLANCO OIL SHALE PROJECT
TRACT C-a
RIO BLANCO COUNTY, COLORADO

TOPOGRAPHIC BASE MAP

SCALE 1" = 2000'

NO. 90

Rio Blanco
Oil Shale Project
PROGRESS REPORT 3

GEOTECHNICAL DATA GATHERING PROJECT

HYDROLOGIC PROGRAM
SECTION 1.2

INTERPRETIVE TEXT APPENDIX

To Area Oil Shale Supervisor
United States Geological Survey

by
Wright Water Engineers
for
Gulf Oil Corporation
and
Standard Oil Company (Indiana)

PROGRESS REPORT 3

GEOTECHNICAL DATA GATHERING PROJECT
HYDROLOGIC PROGRAM
SECTION 1.2

INTERPRETIVE TEXT
APPENDIX

JULY 15, 1975

TO

AREA OIL SHALE SUPERVISOR
UNITED STATES GEOLOGICAL SURVEY

By

WRIGHT WATER ENGINEERS, INC.
For
Gulf Oil Corporation
and
Standard Oil Company (Indiana)

TABLE OF CONTENTS

Section Number

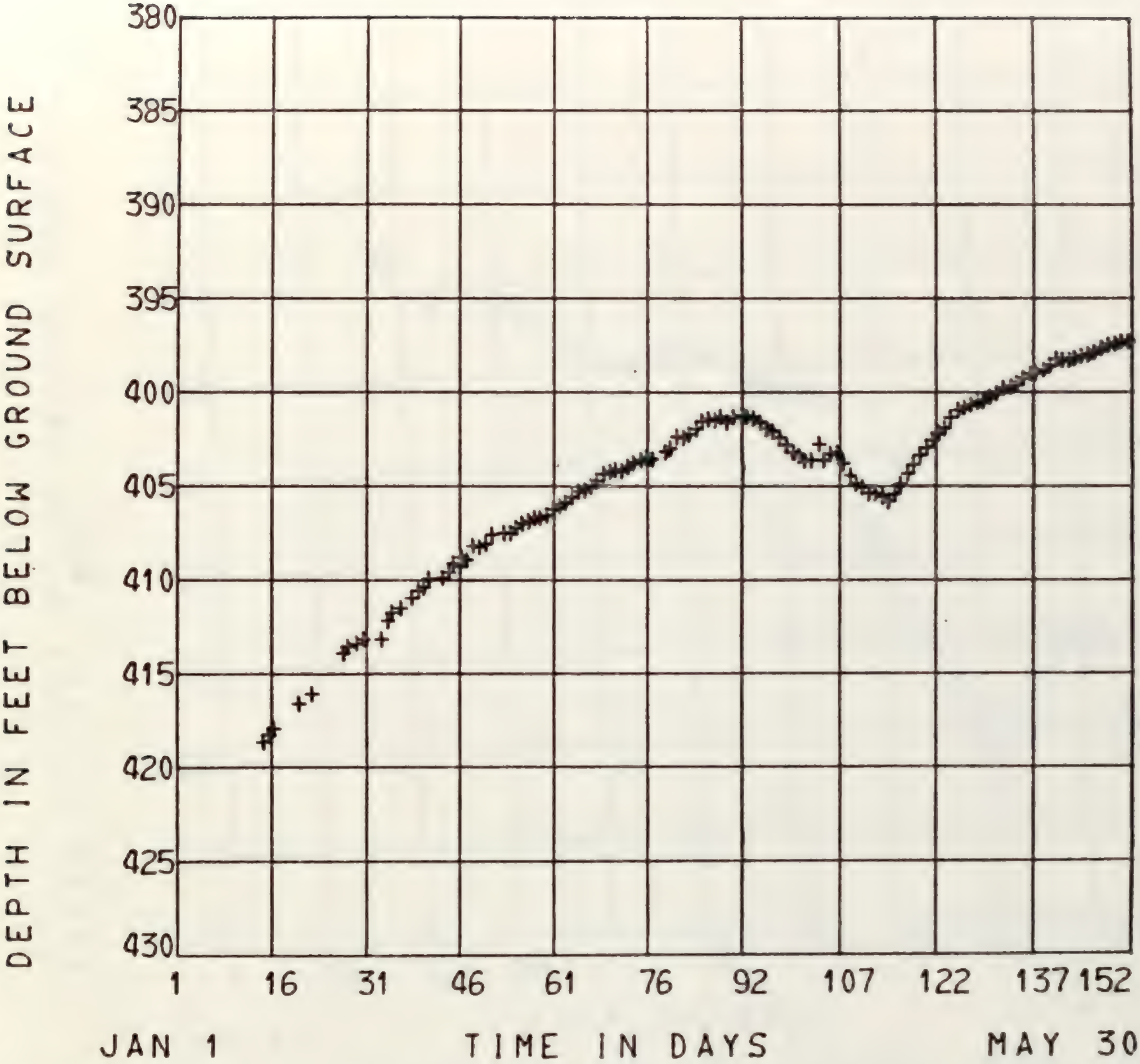
Upper and Lower Aquifer Pumping Tests - Appendix 1.2.6

Deep Aquifer Hydrographs: Pumping Test Holes and Deep Aquifer Monitor Holes

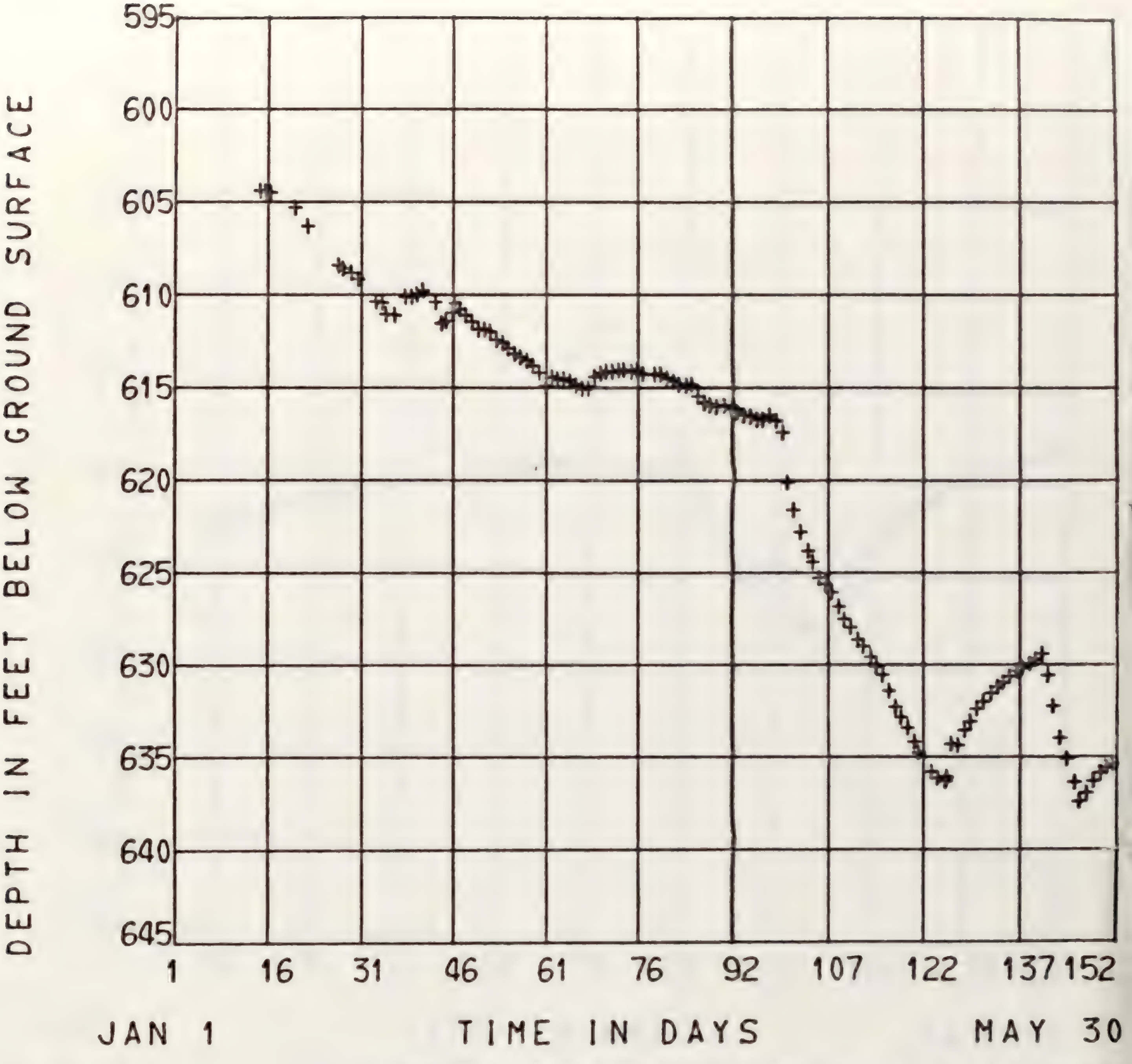
Simplified Jacobs Plots: Pumping Tests Holes and Deep Aquifer Monitoring Holes Responding To Individual Pumping Test

DEEP AQUIFER HYDROGRAPHS

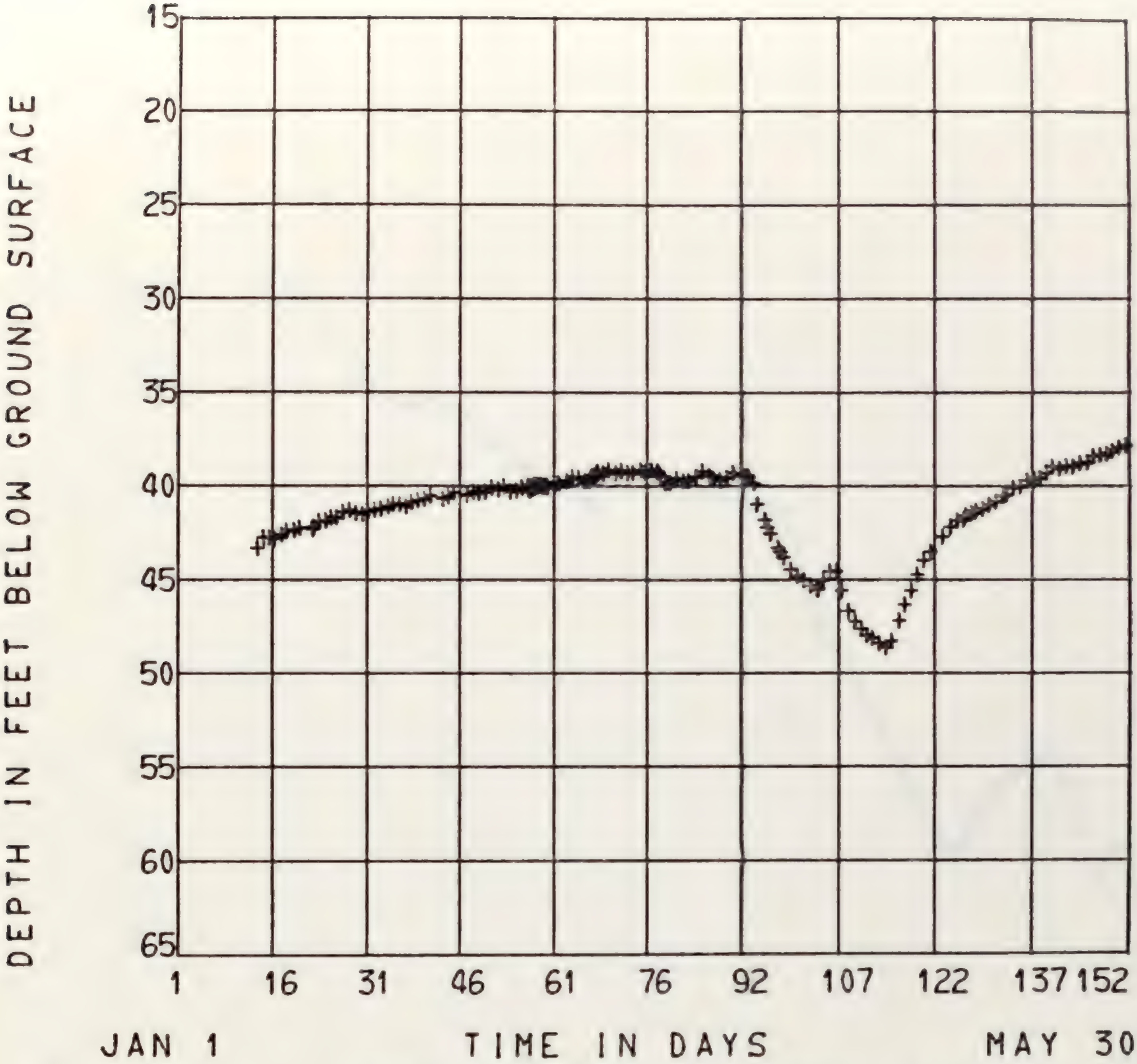
Pumping Tests and Deep Aquifer Monitor Holes



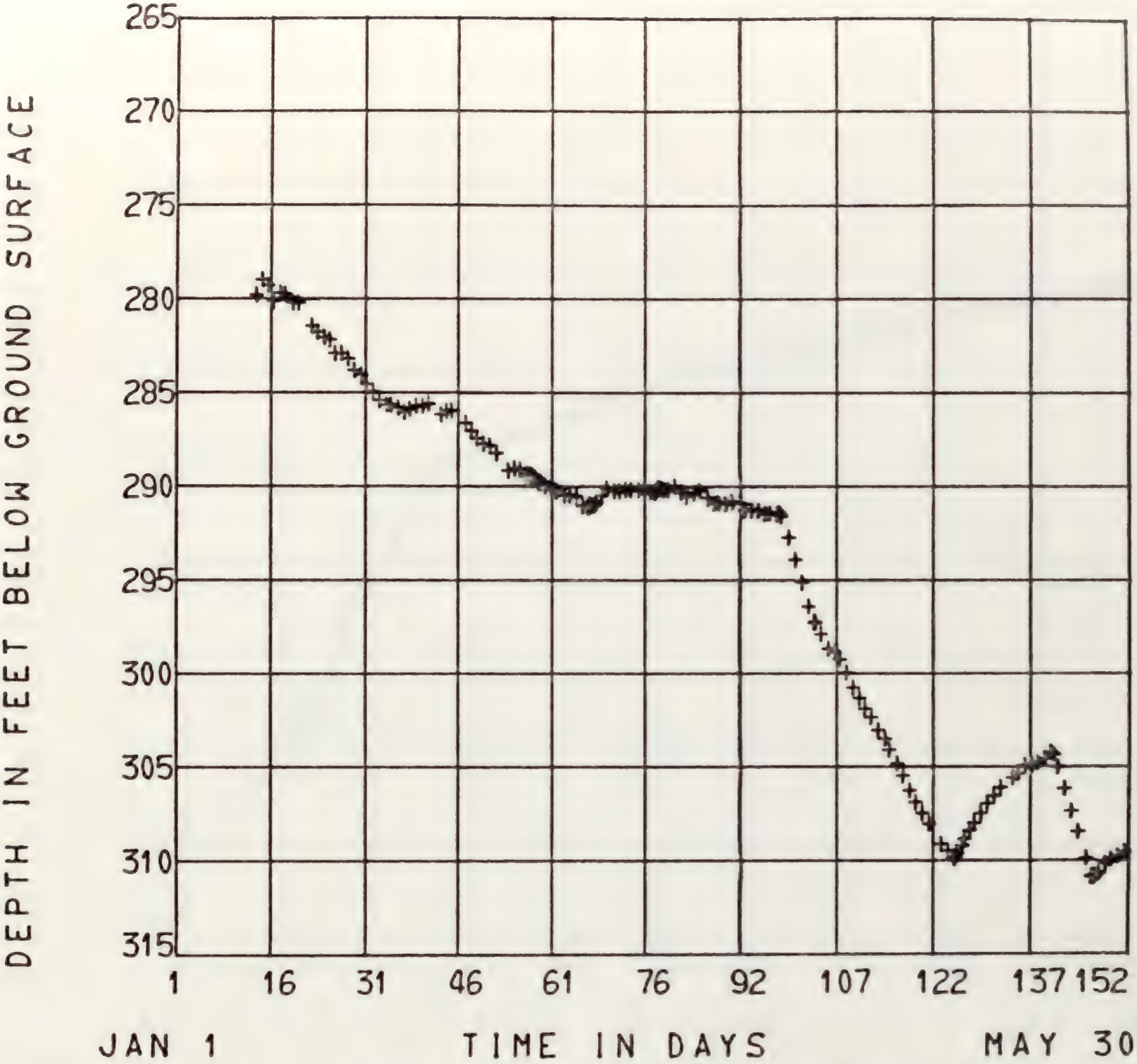
AM-2A HYDROGRAPH UPPR AQUIFER



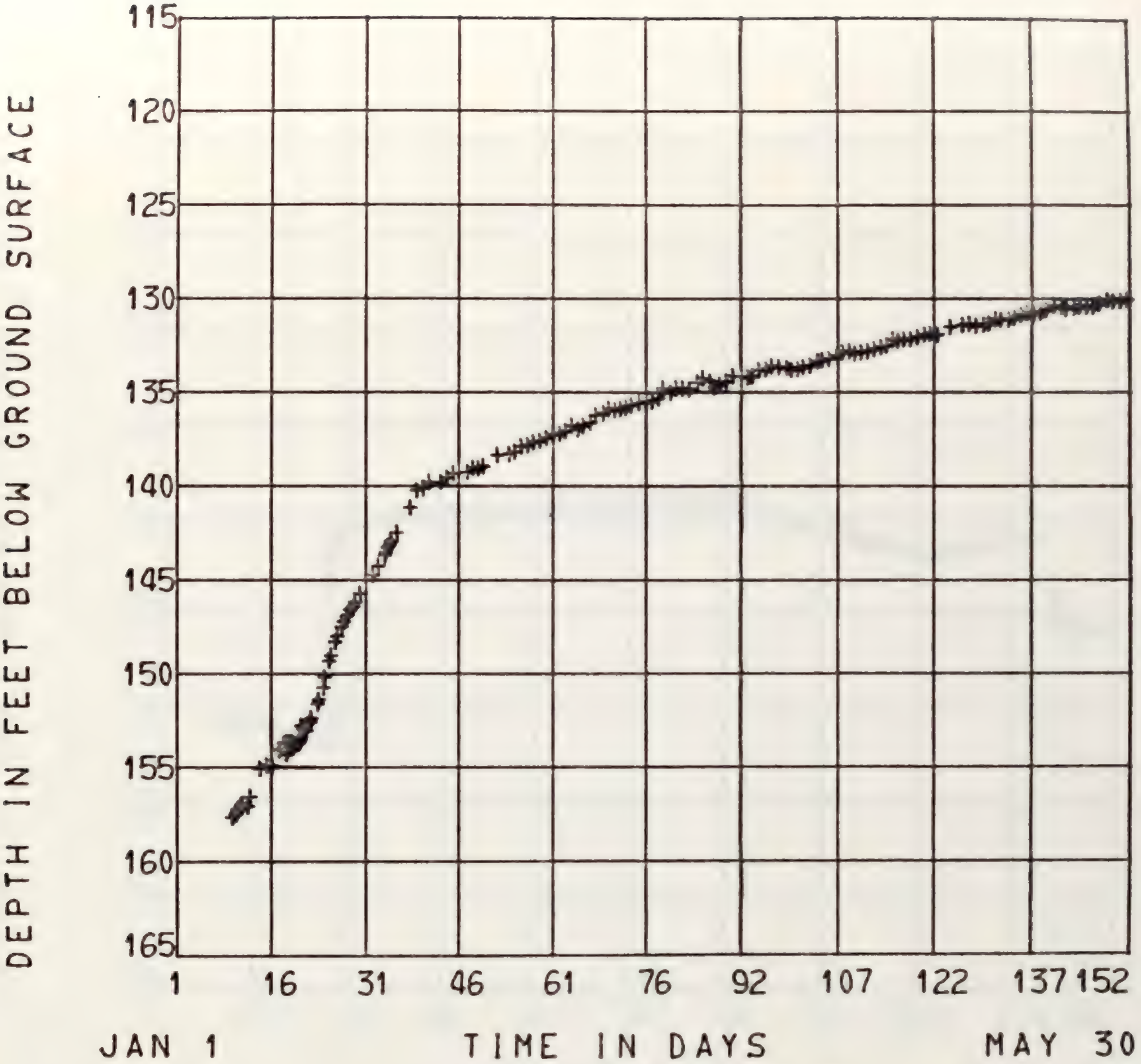
AM-2A HYDROGRAPH LOWR AQUIFER



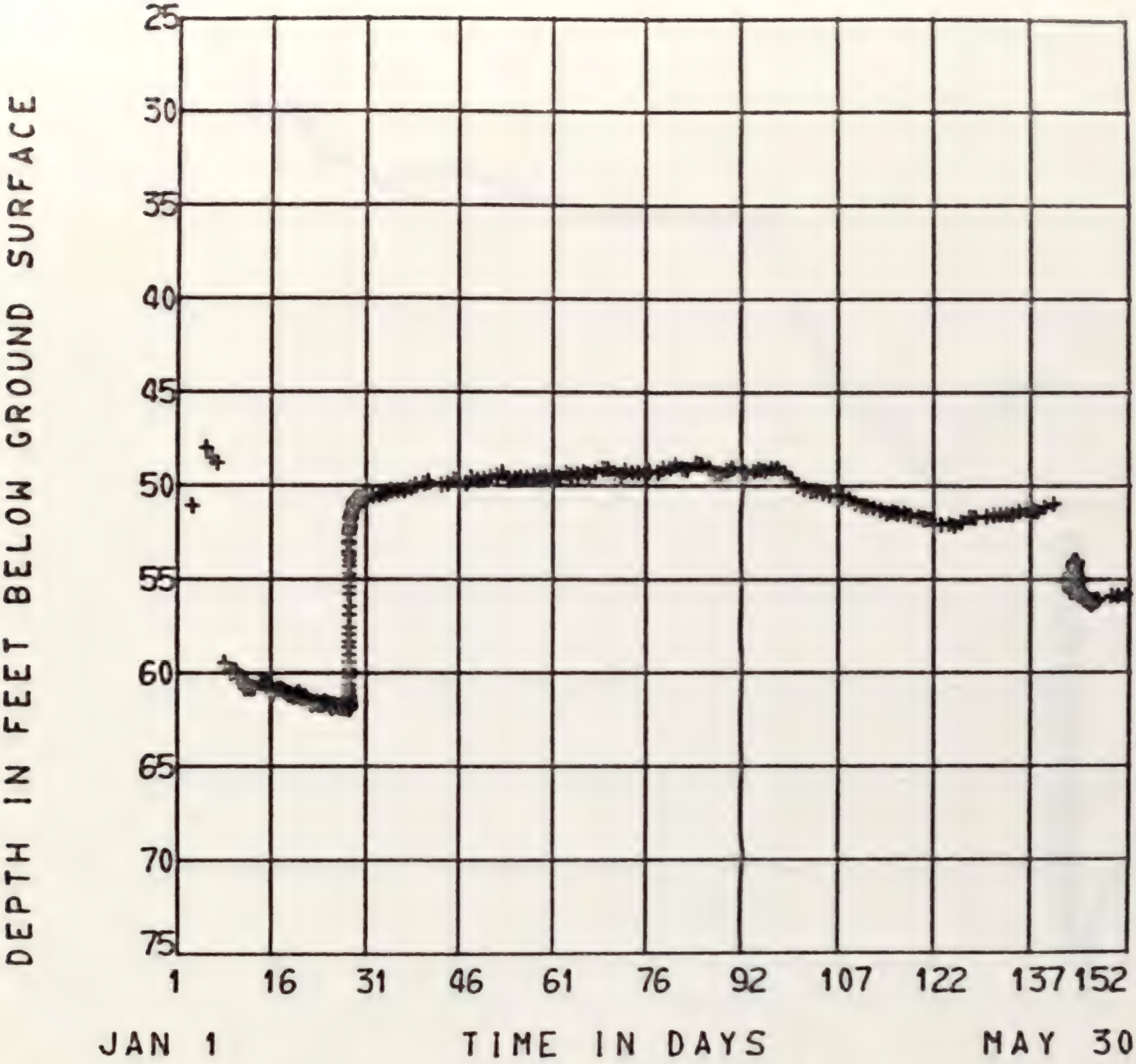
AM-3 HYDROGRAPH UPPR AQUIFER



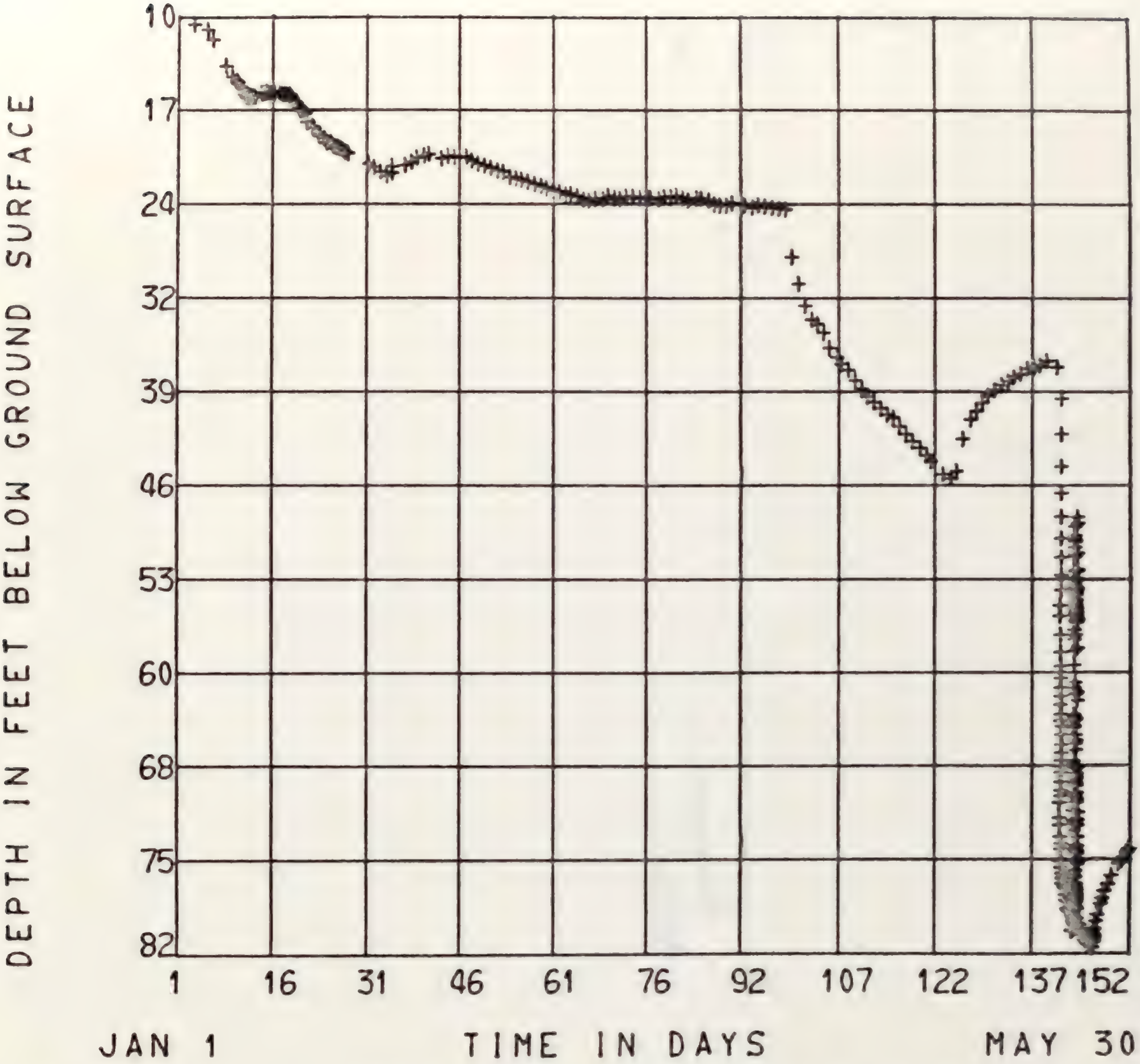
AM-3 HYDROGRAPH LOWR AQUIFER



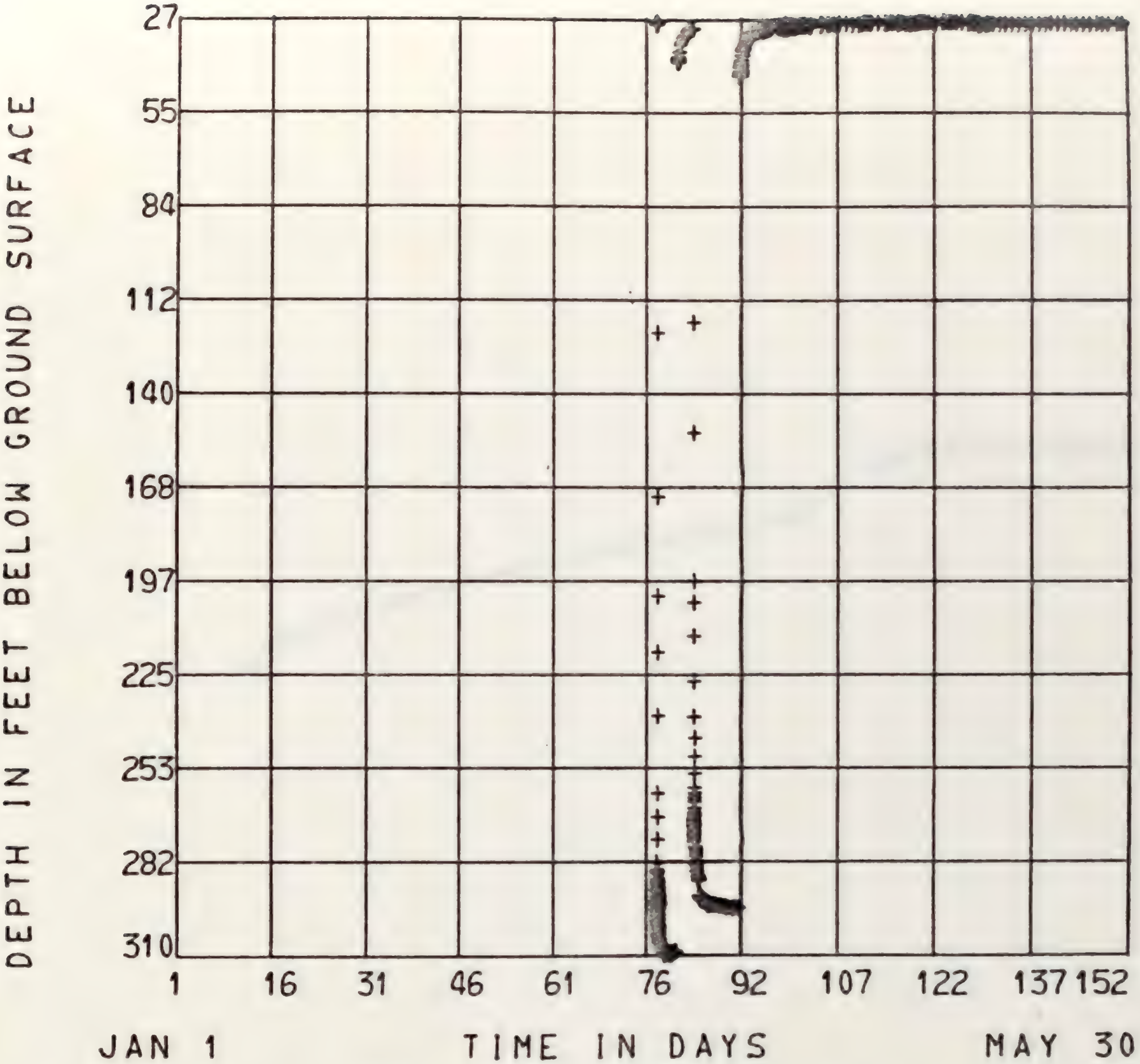
CE 701 HYDROGRAPH UPPR AQUIFER



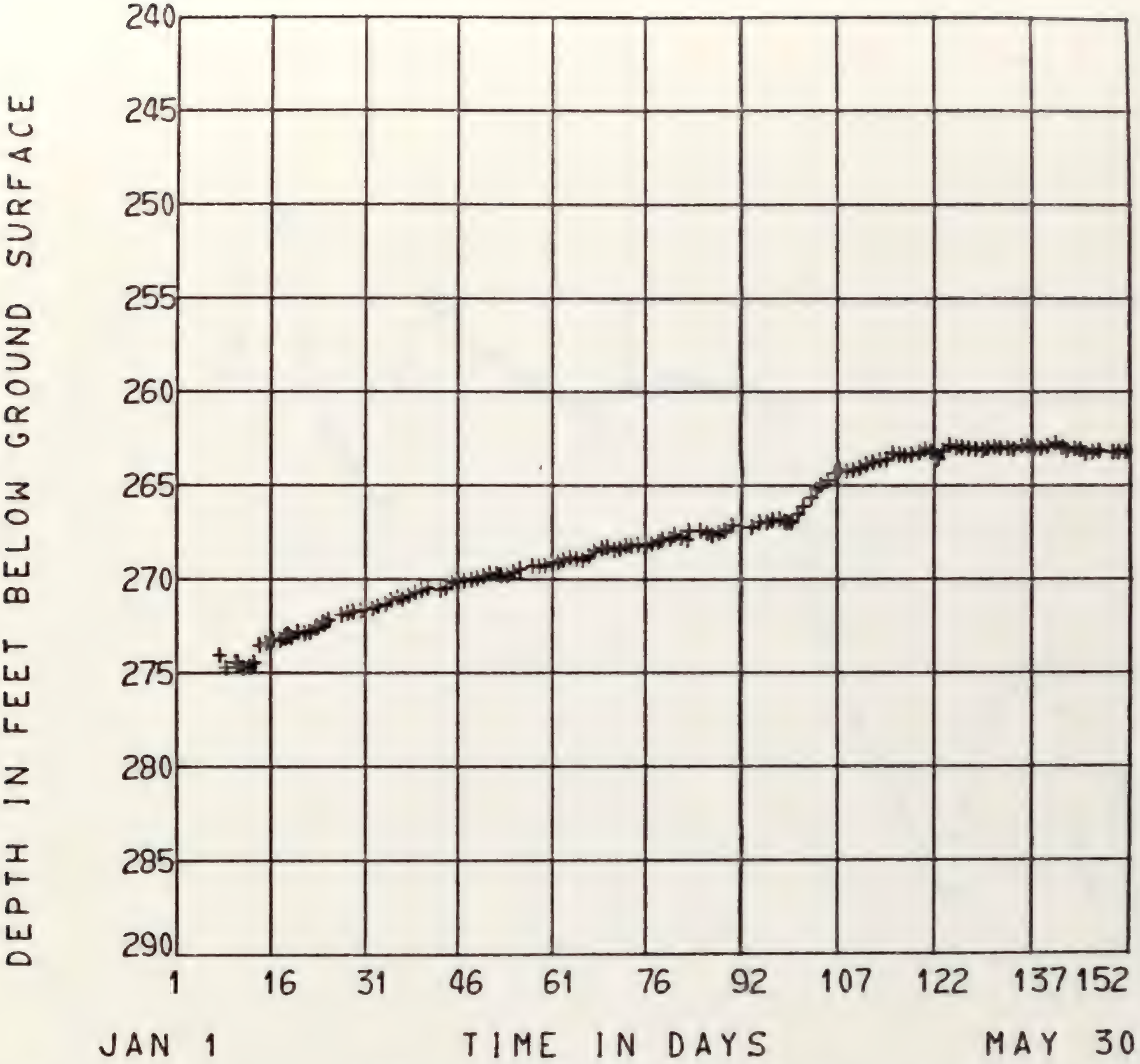
CE 702 HYDROGRAPH UPPR AQUIFER



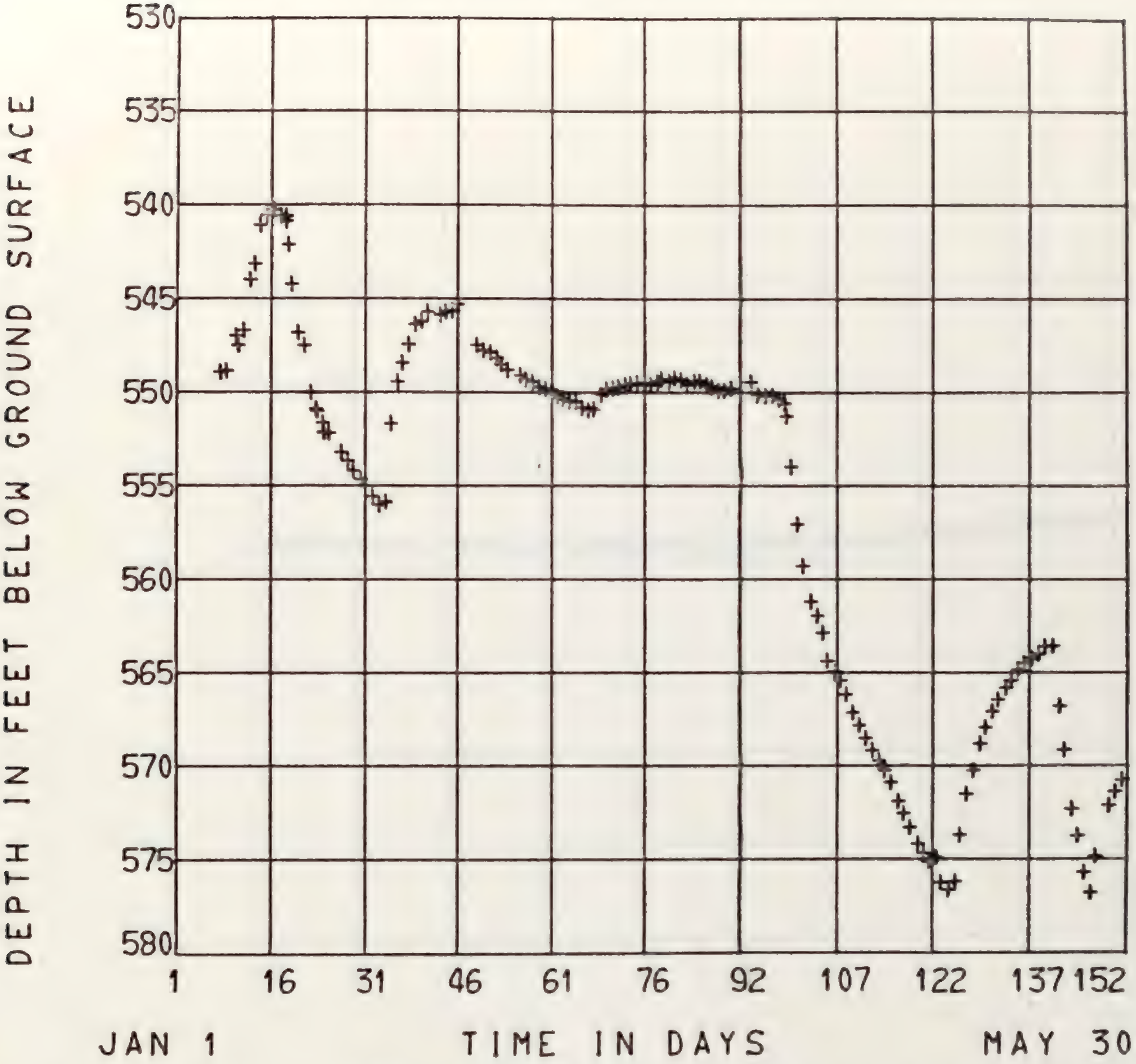
CE 702 HYDROGRAPH LOWR AQUIFER



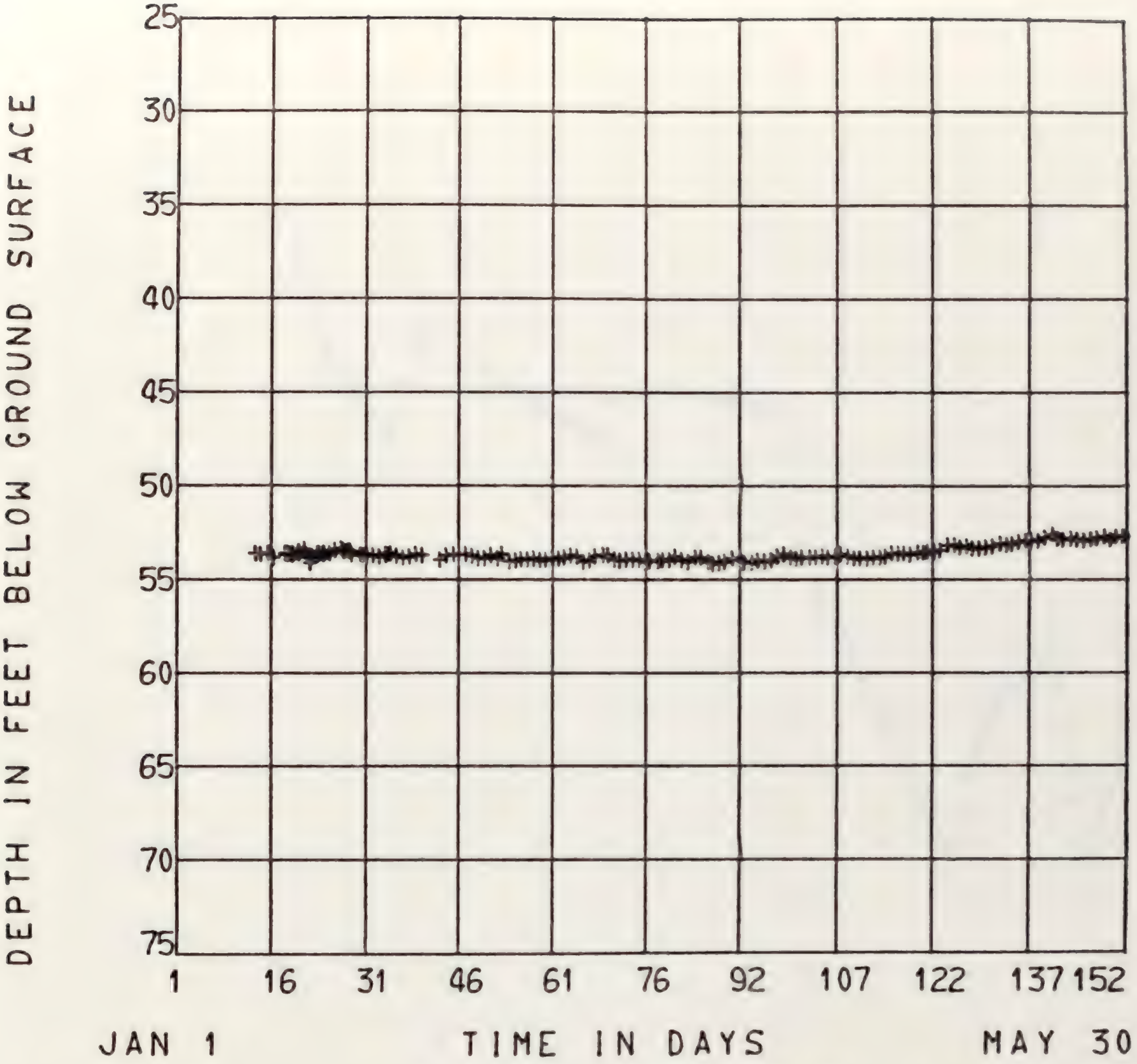
CE 705A HYDROGRAPH UPPR AQUIFER



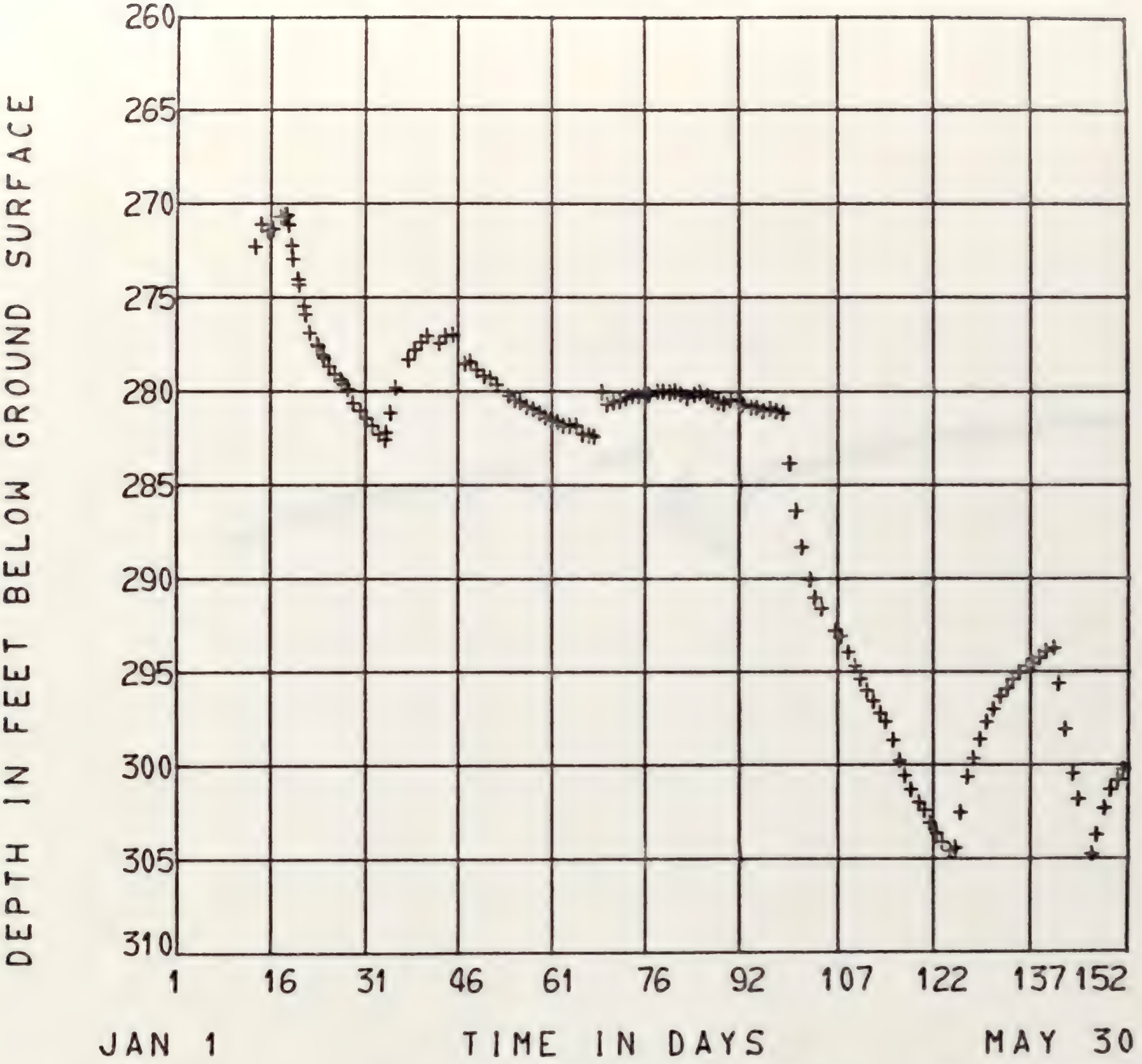
CE 707 HYDROGRAPH UPPR AQUIFER



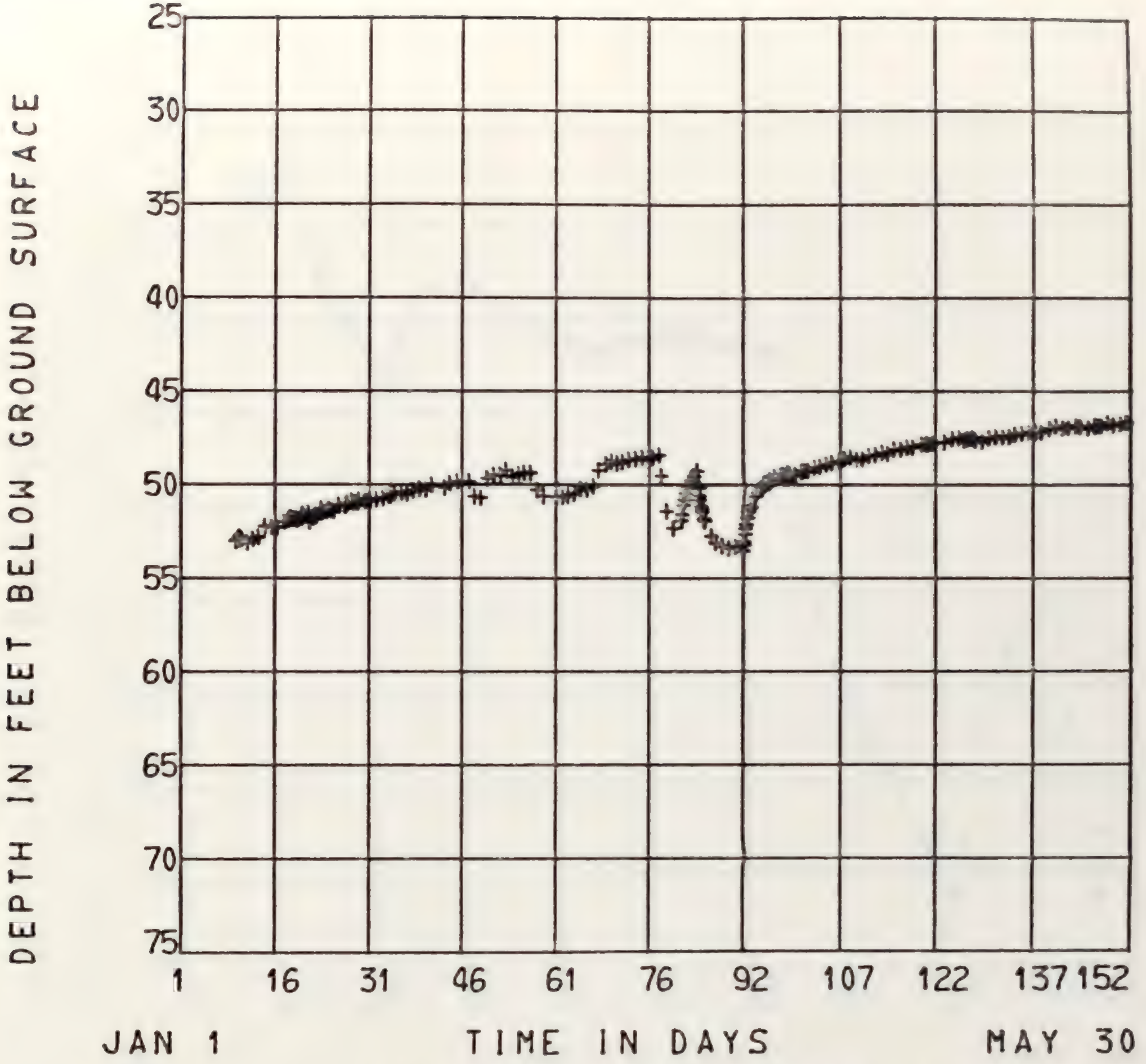
CE 707 HYDROGRAPH LOWR AQUIFER



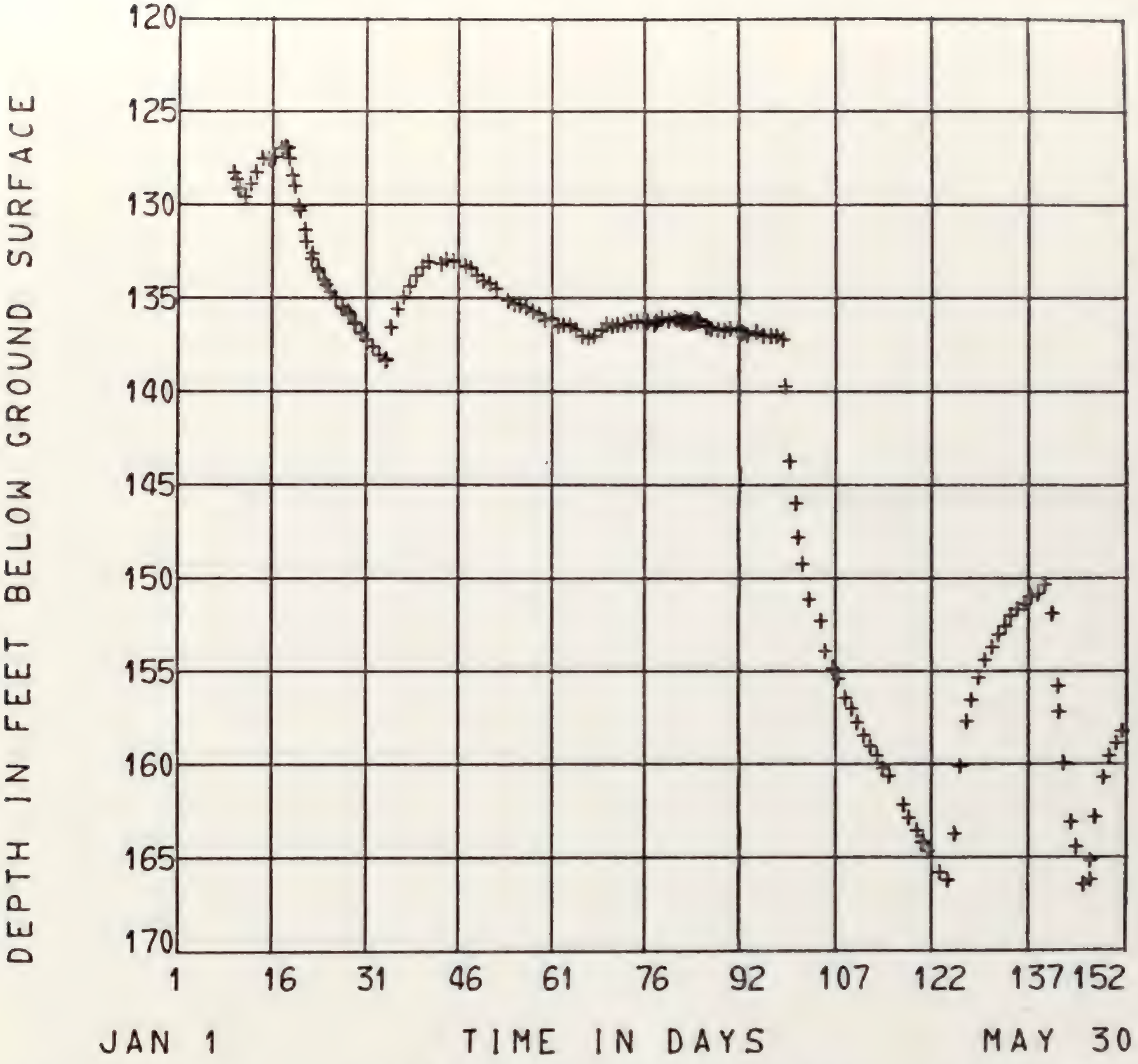
CE 708 HYDROGRAPH UPPR AQUIFER



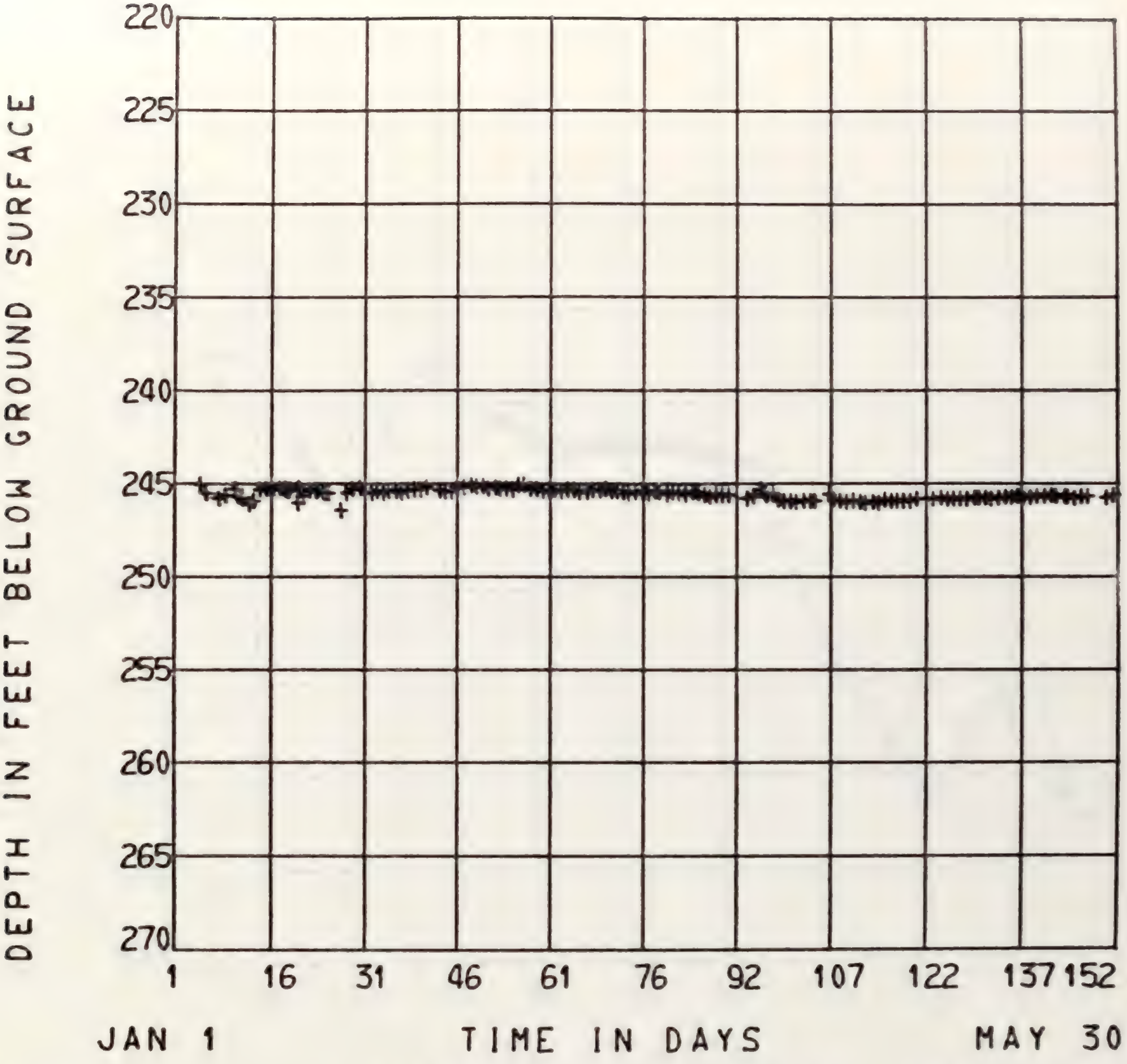
CE 708 HYDROGRAPH LOWR AQUIFER



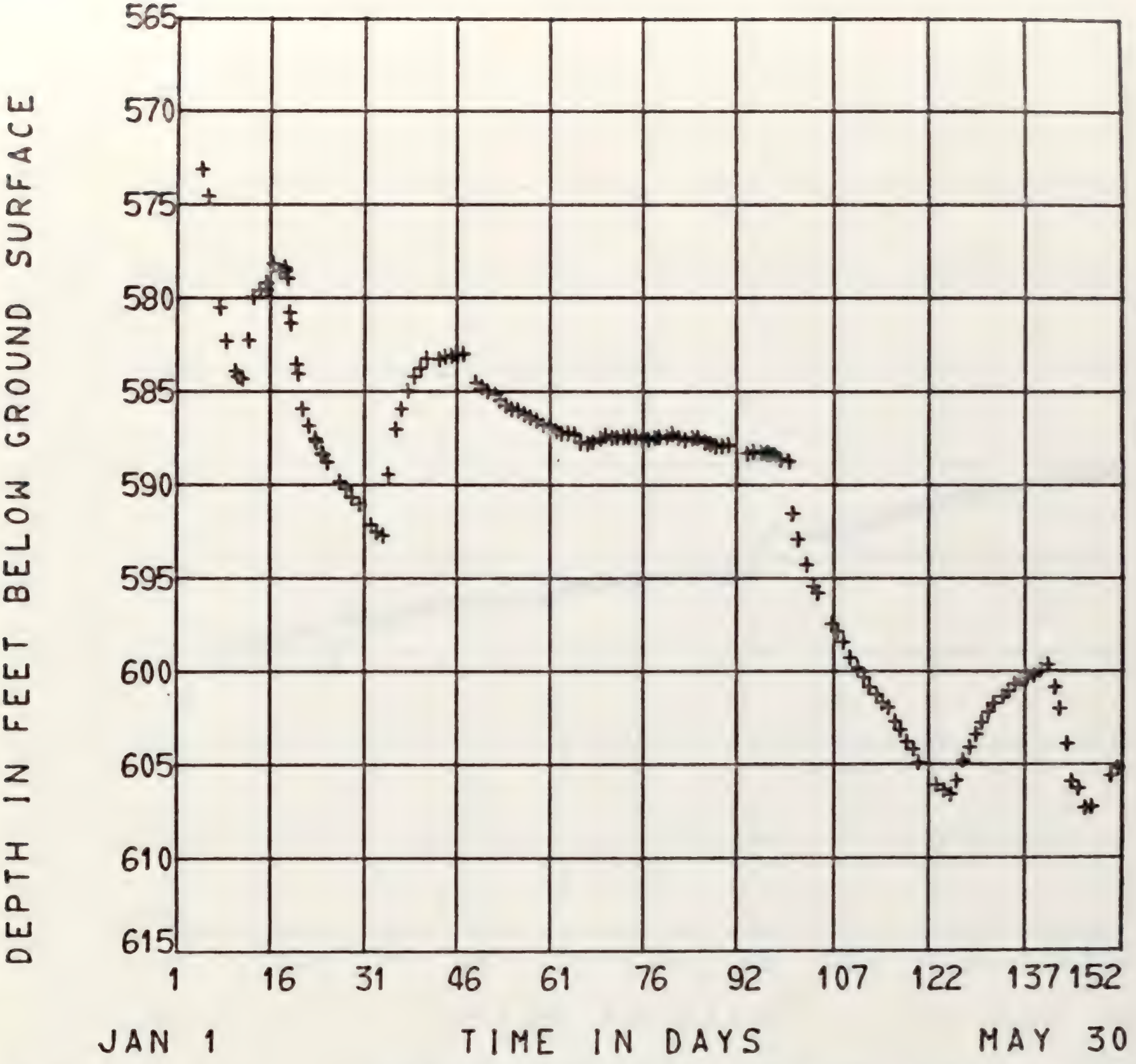
CE 709 HYDROGRAPH UPPR AQUIFER



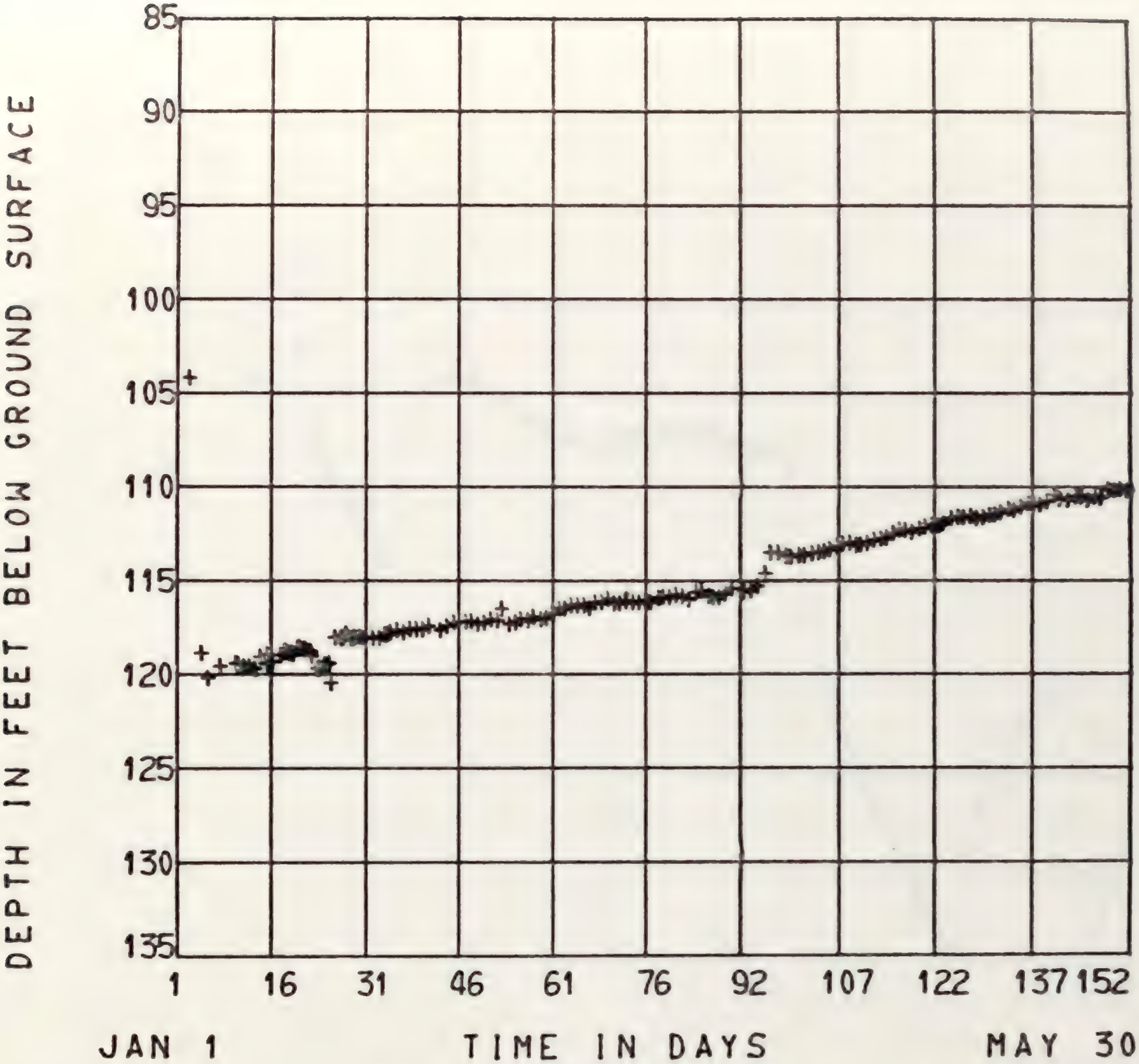
CE 709 HYDROGRAPH LOWR AQUIFER



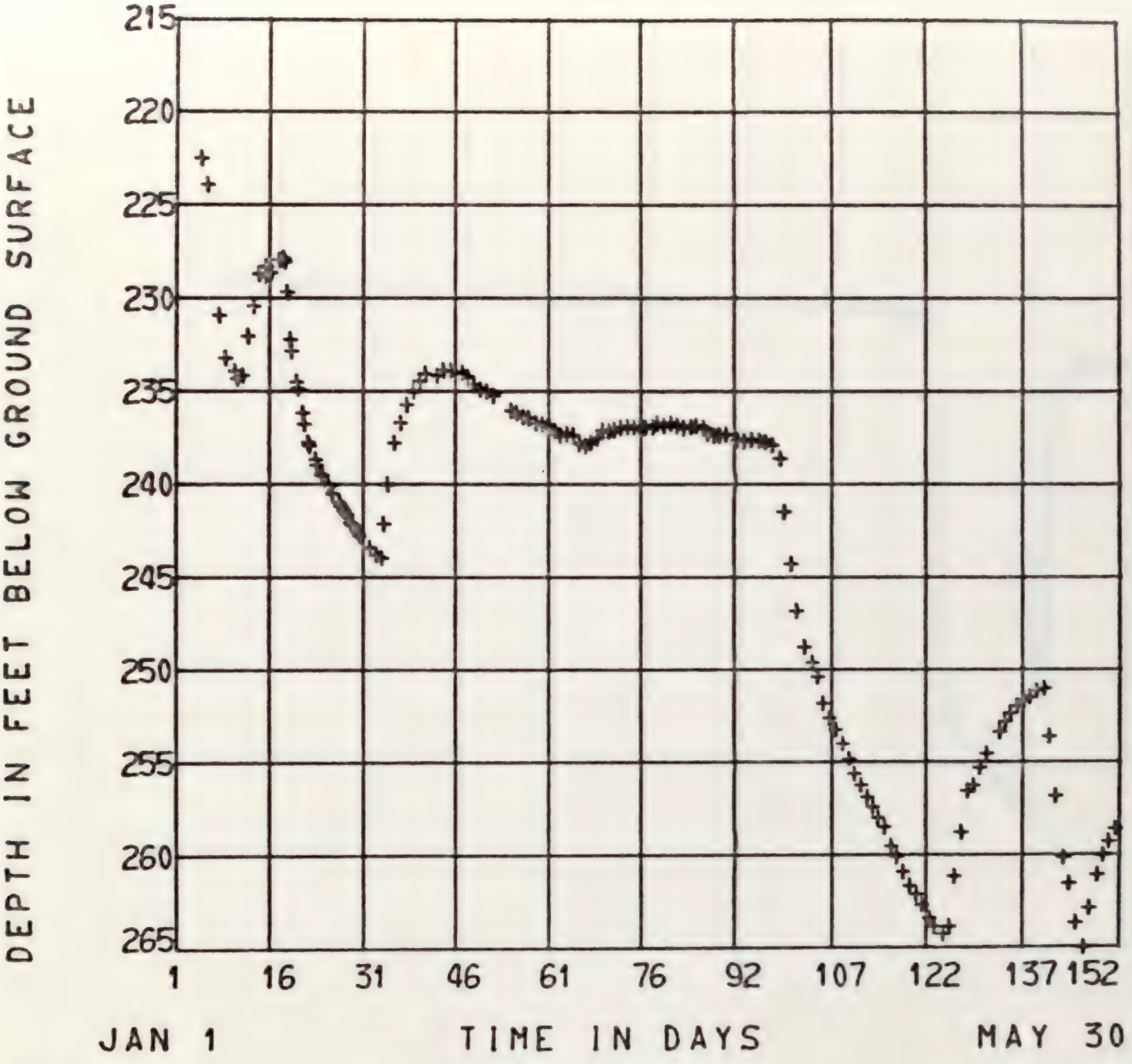
GS-1 HYDROGRAPH UPPR AQUIFER



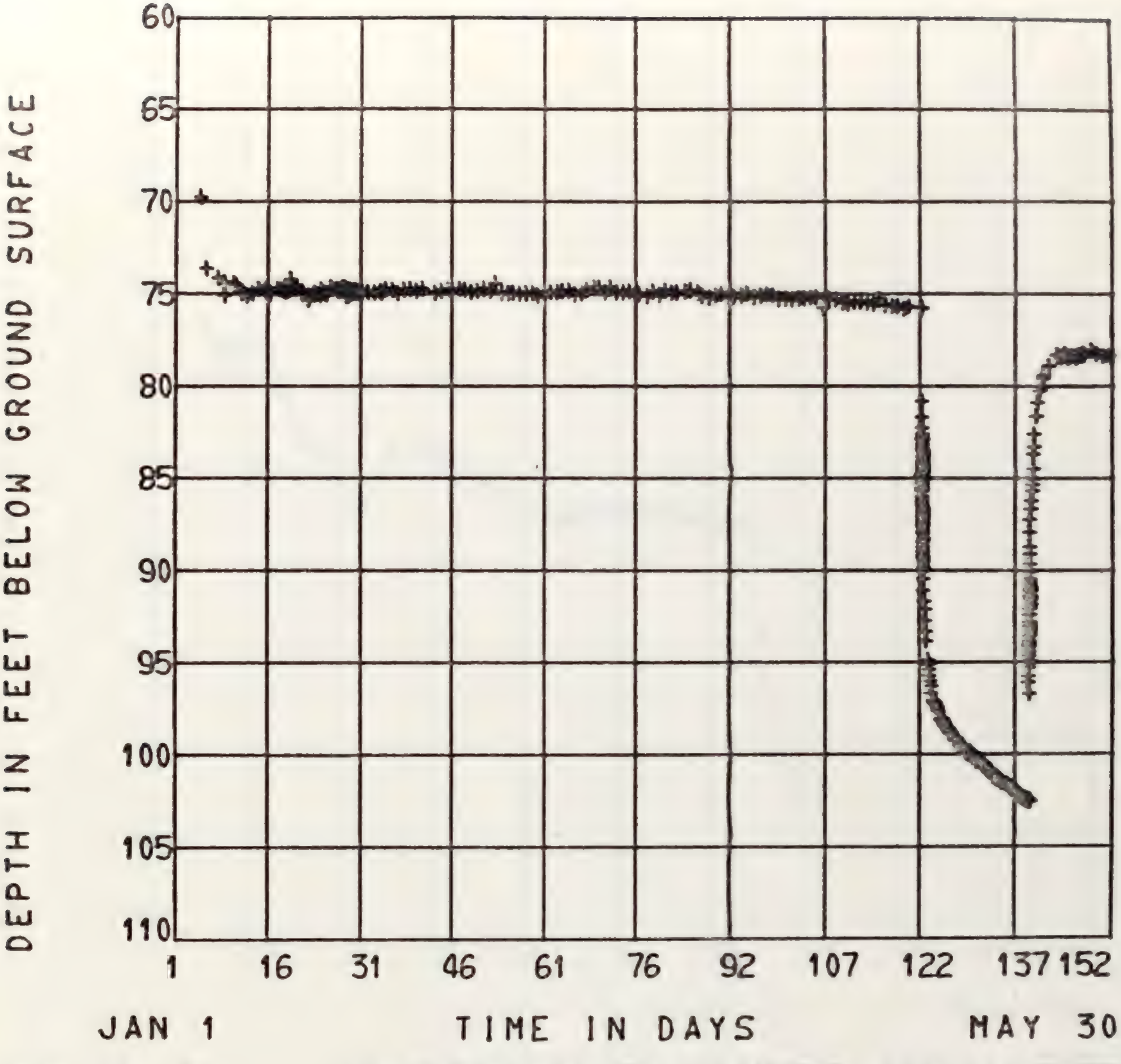
GS-1 HYDROGRAPH LOWR AQUIFER



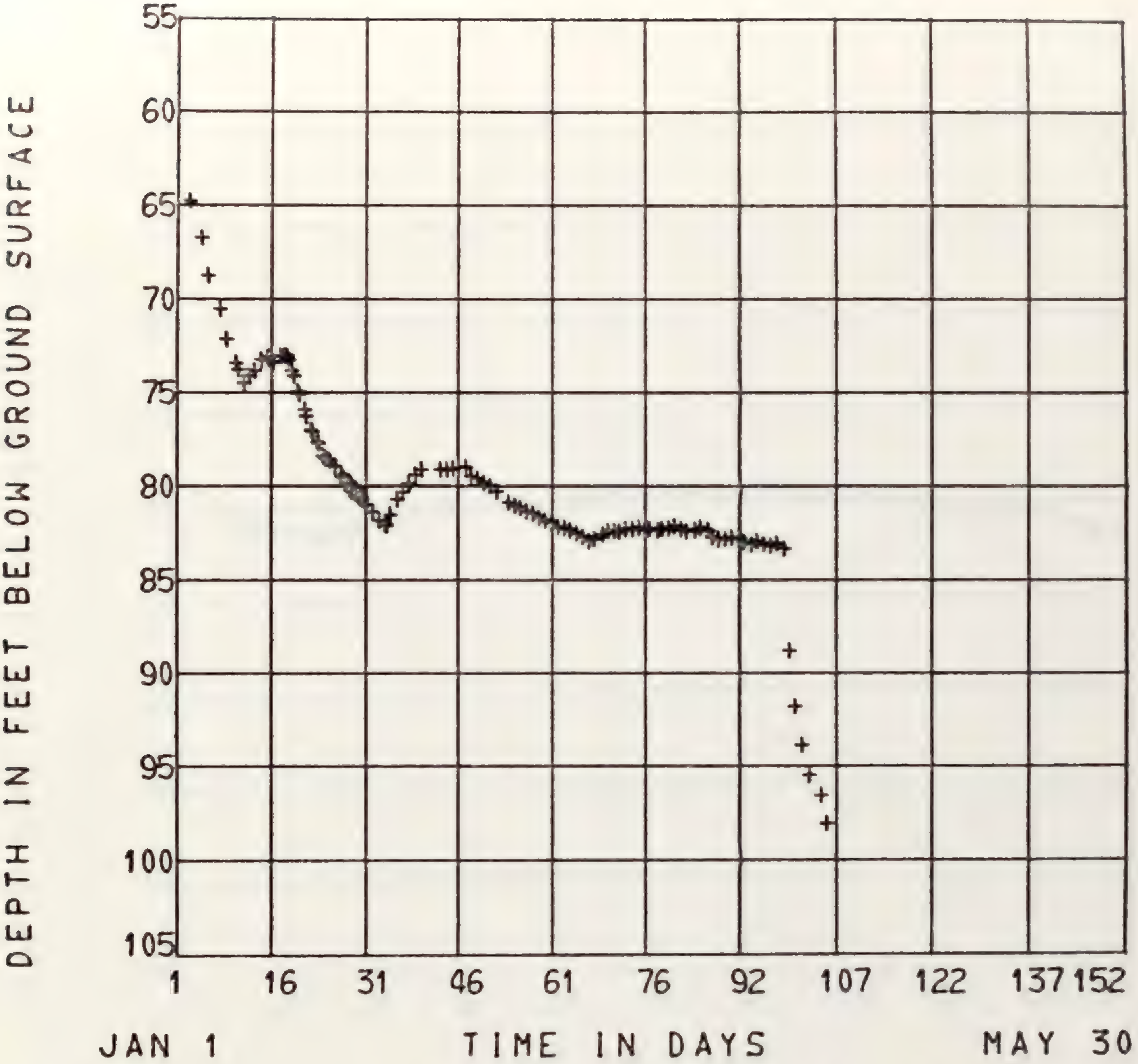
GS-2-3 HYDROGRAPH UPPR AQUIFER



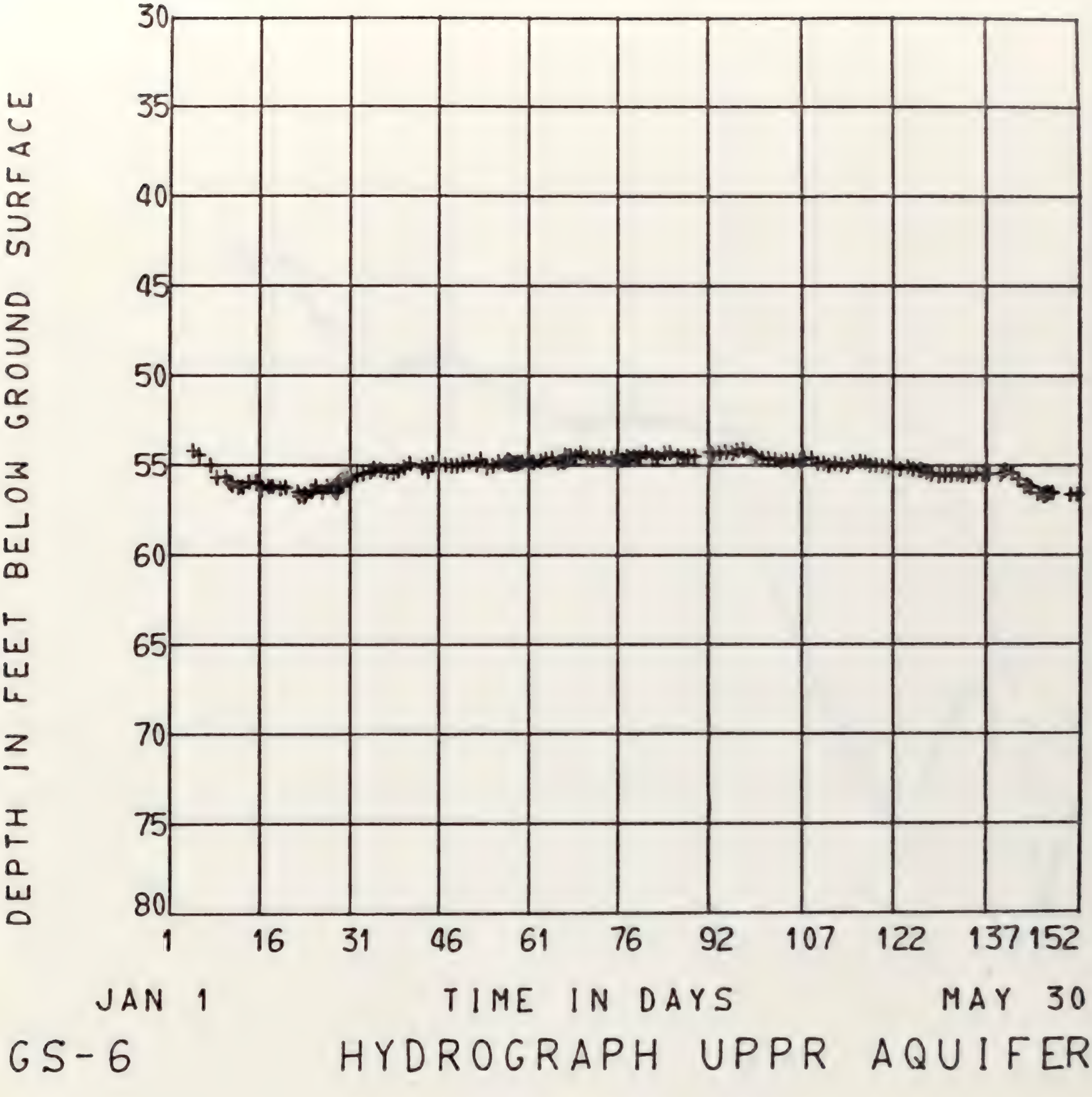
GS-2-3 HYDROGRAPH LOWR AQUIFER



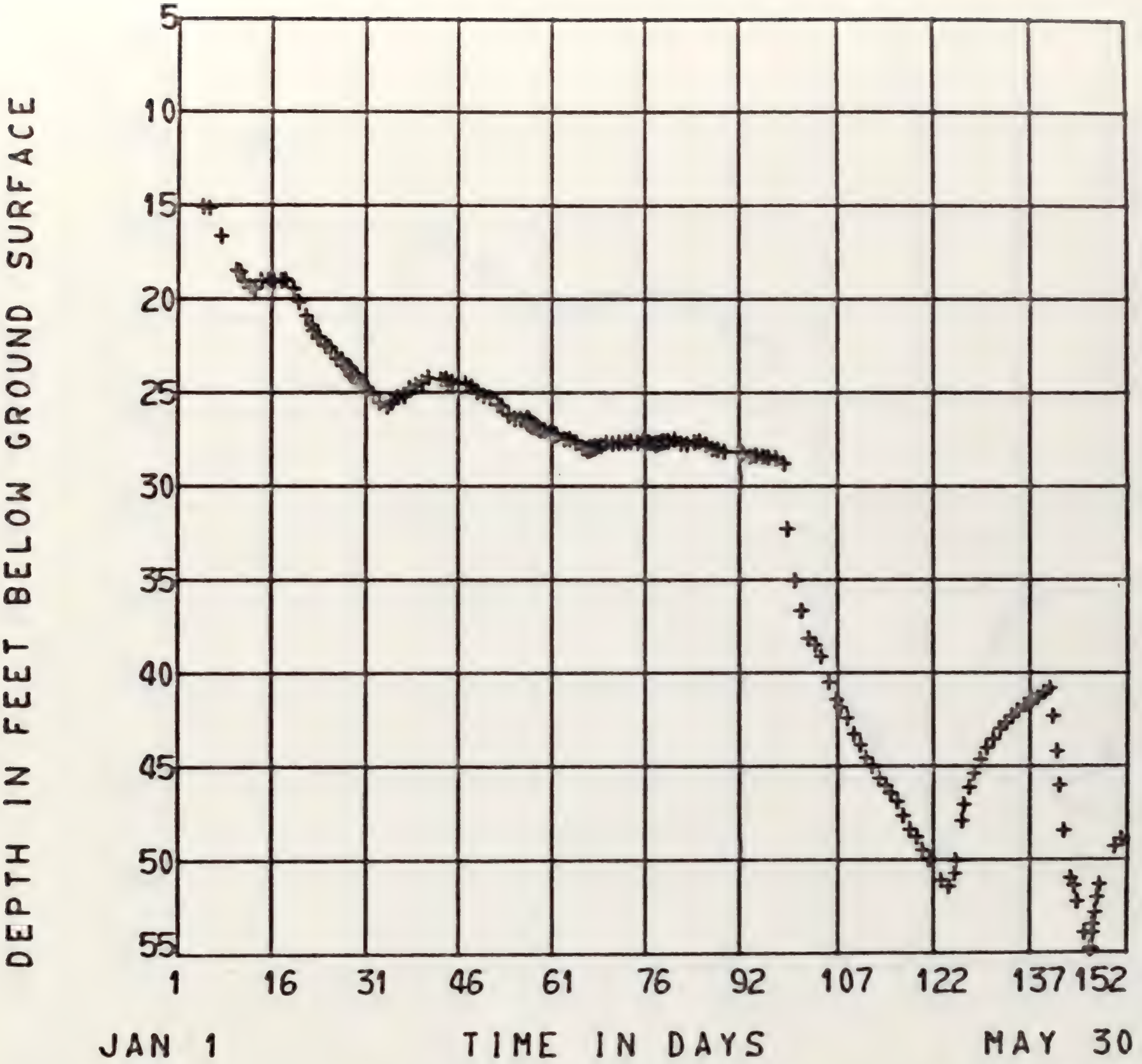
GS-4-5 HYDROGRAPH UPPR AQUIFER



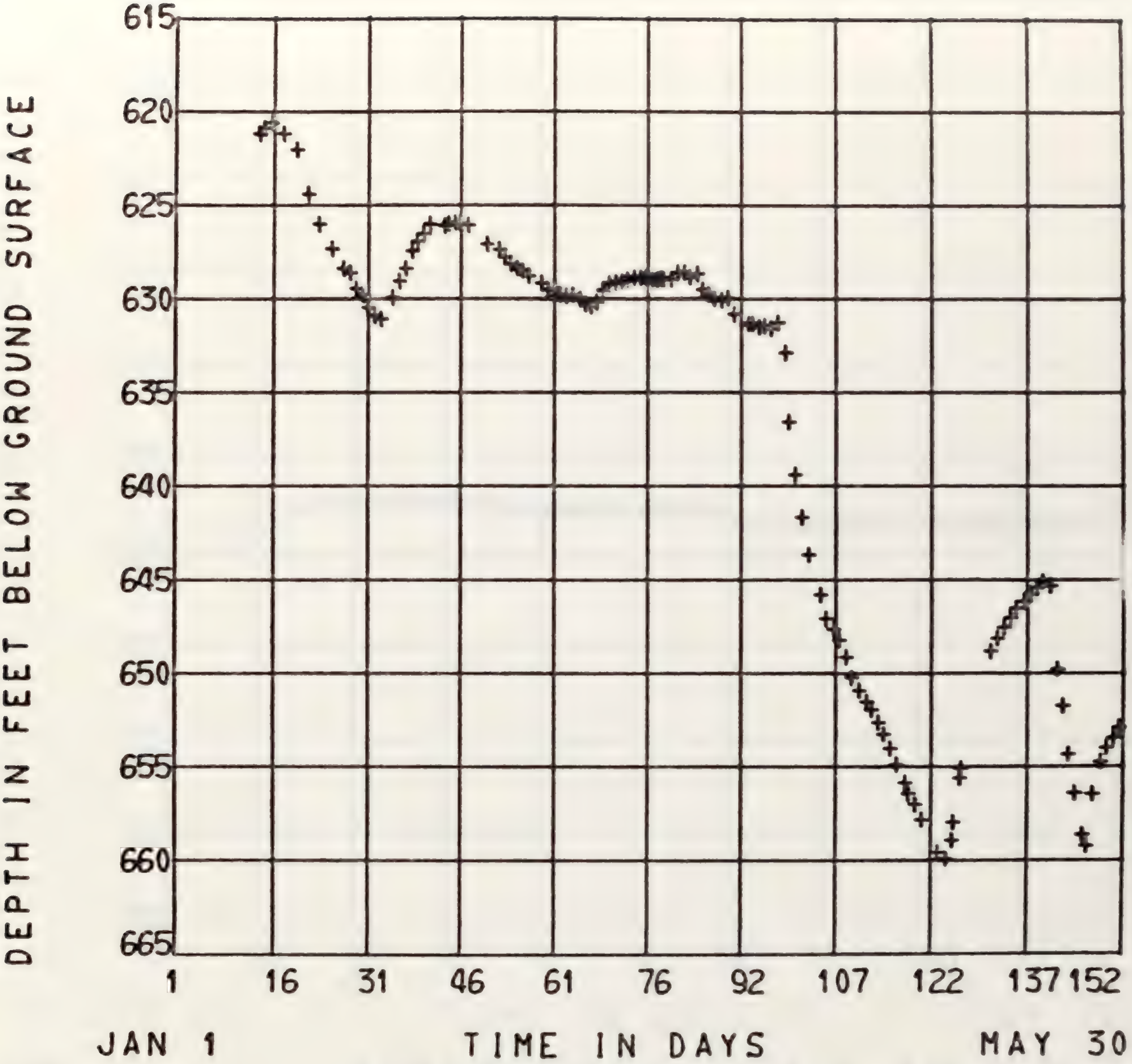
GS-4-5 HYDROGRAPH LOWR AQUIFER



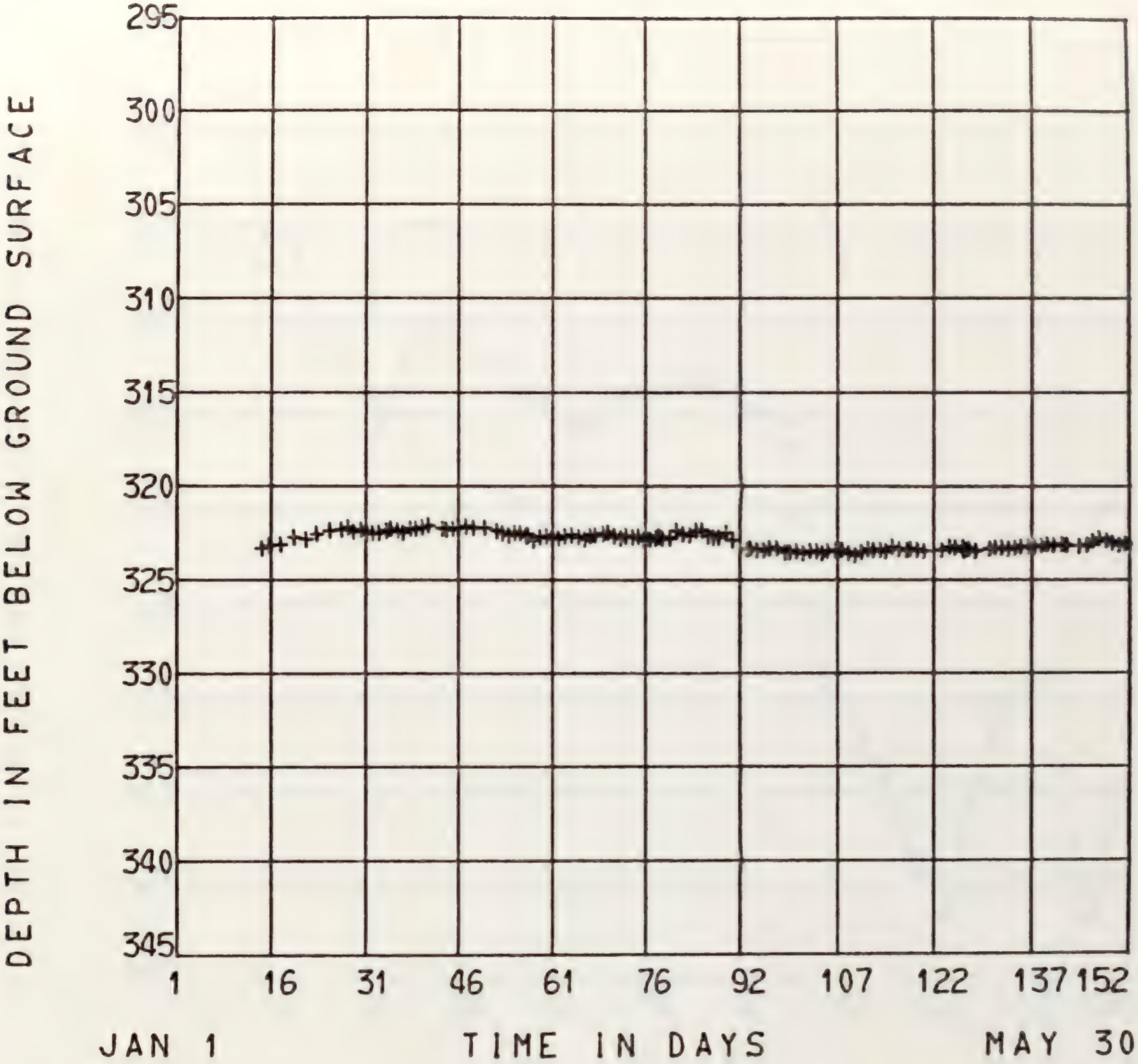
GS-6 HYDROGRAPH UPPR AQUIFER



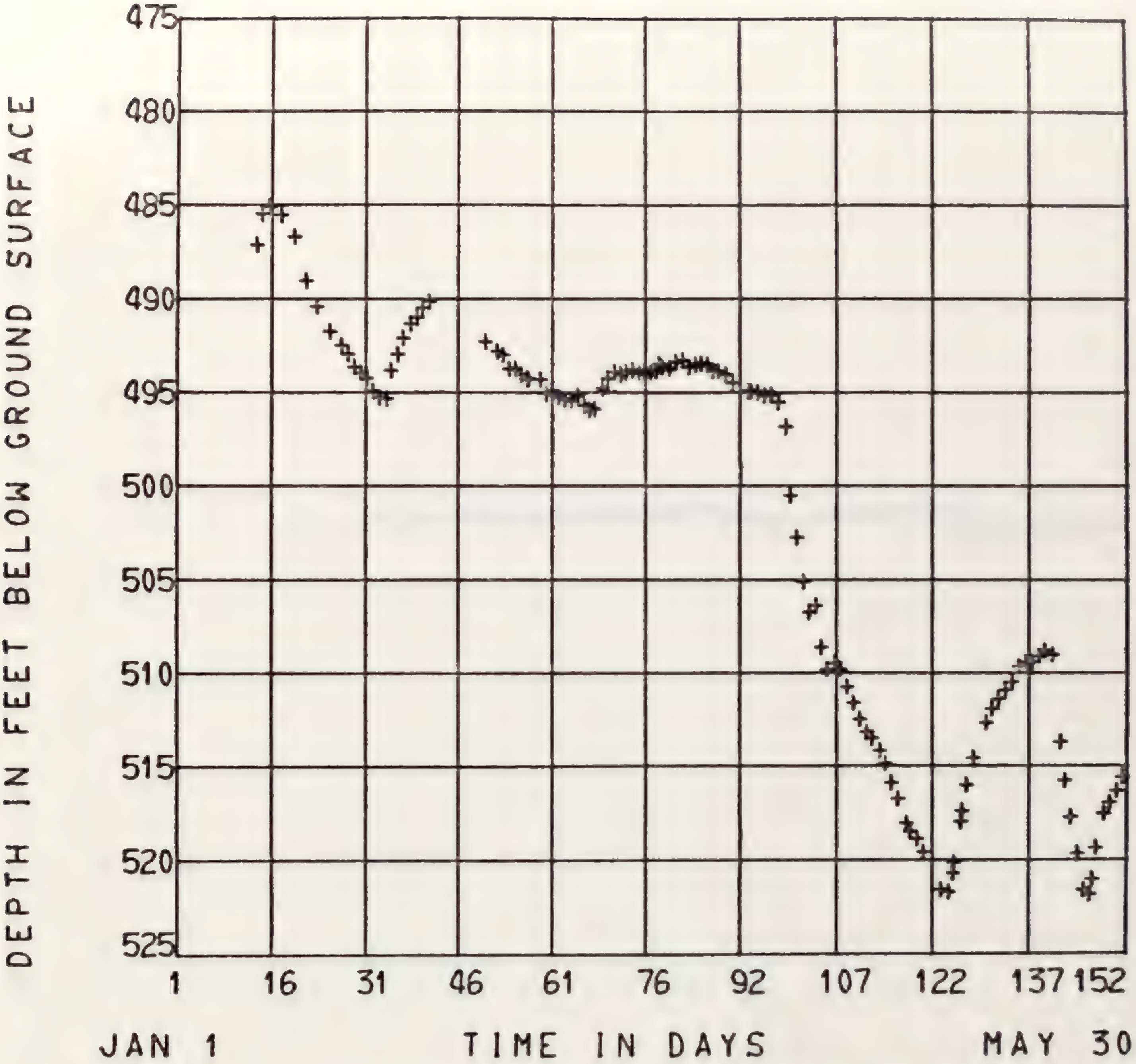
GS-6 HYDROGRAPH LOWR AQUIFER



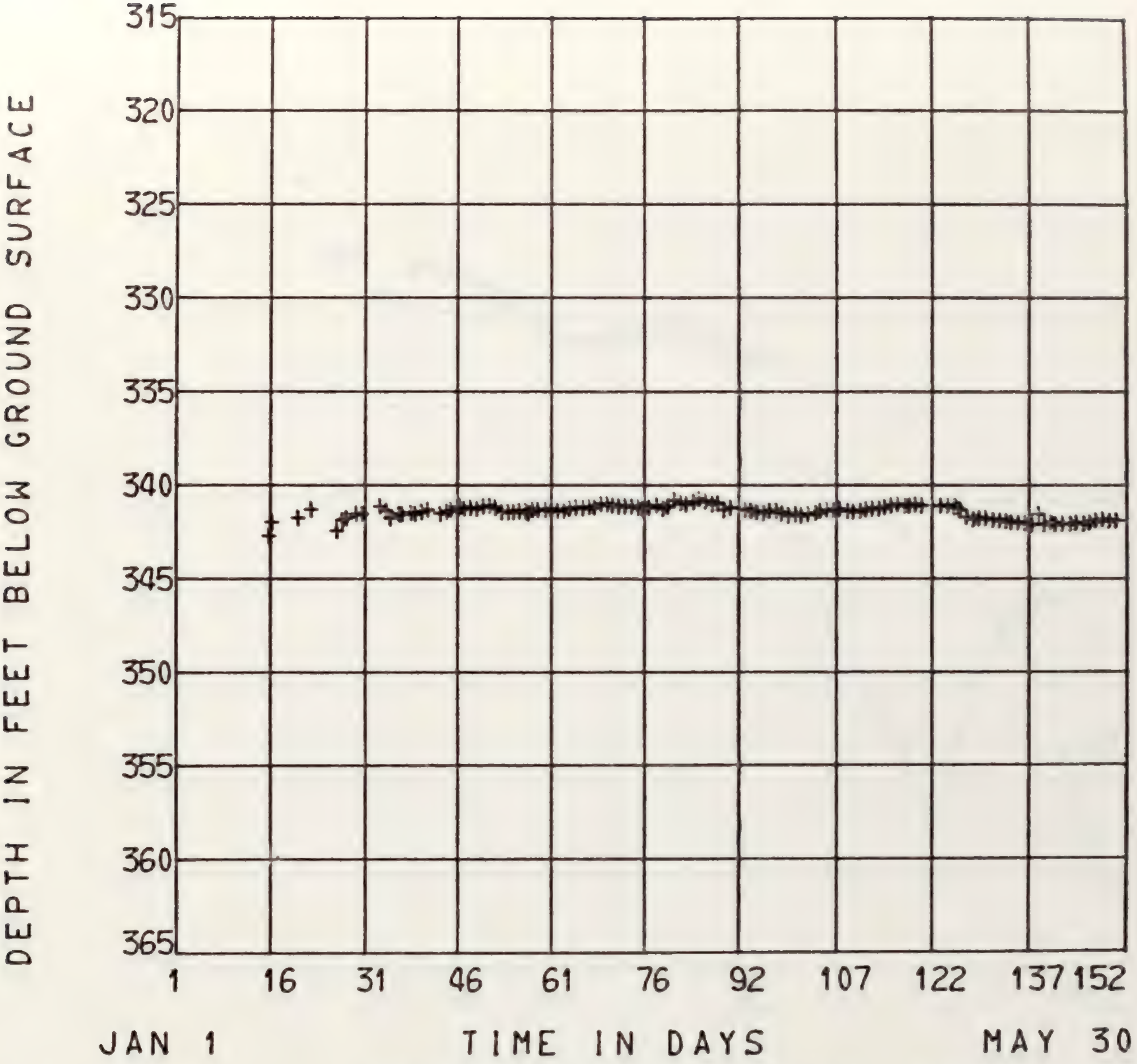
GS-8 HYDROGRAPH LOWR AQUIFER



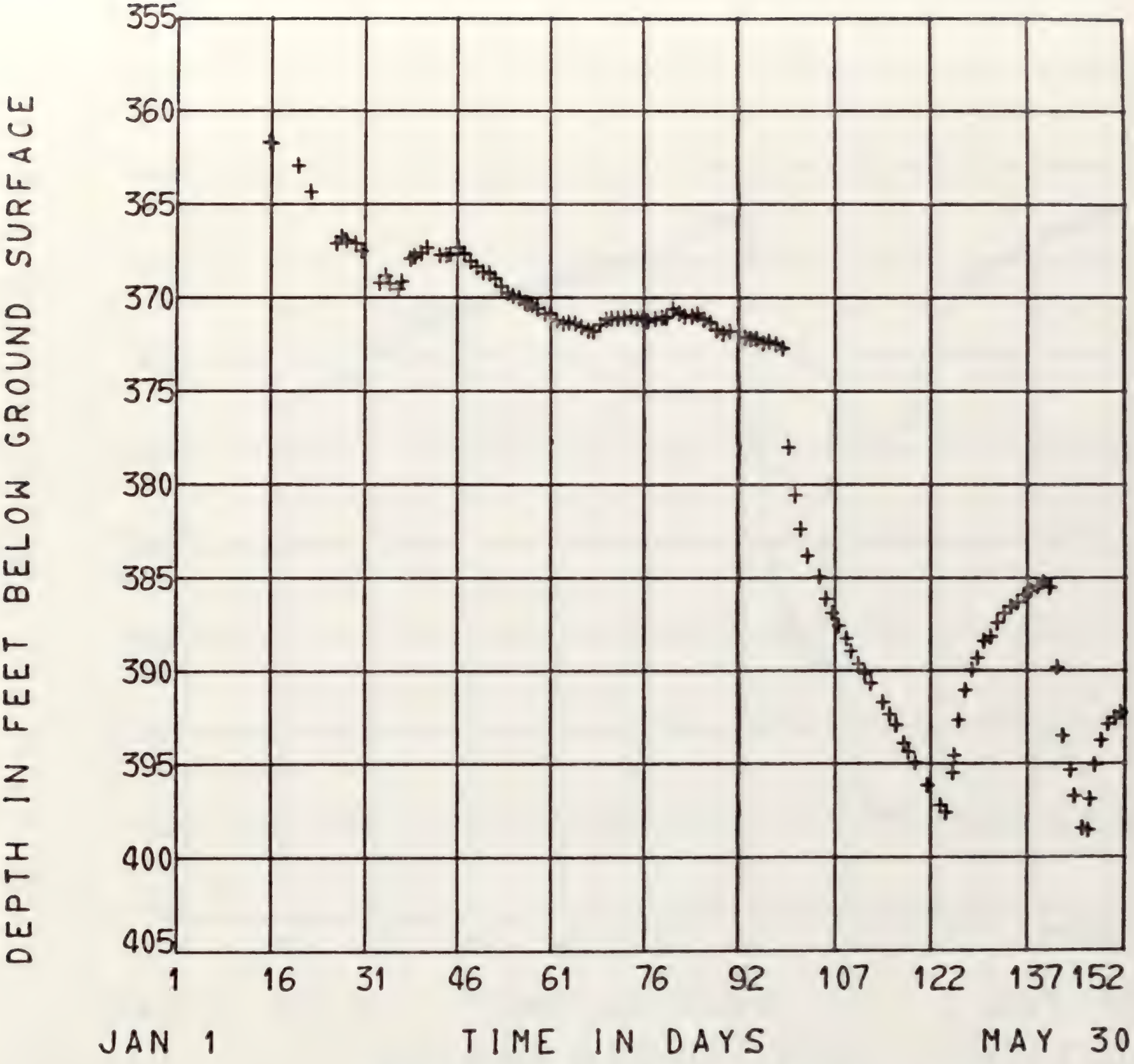
GS-9 HYDROGRAPH UPPR AQUIFER



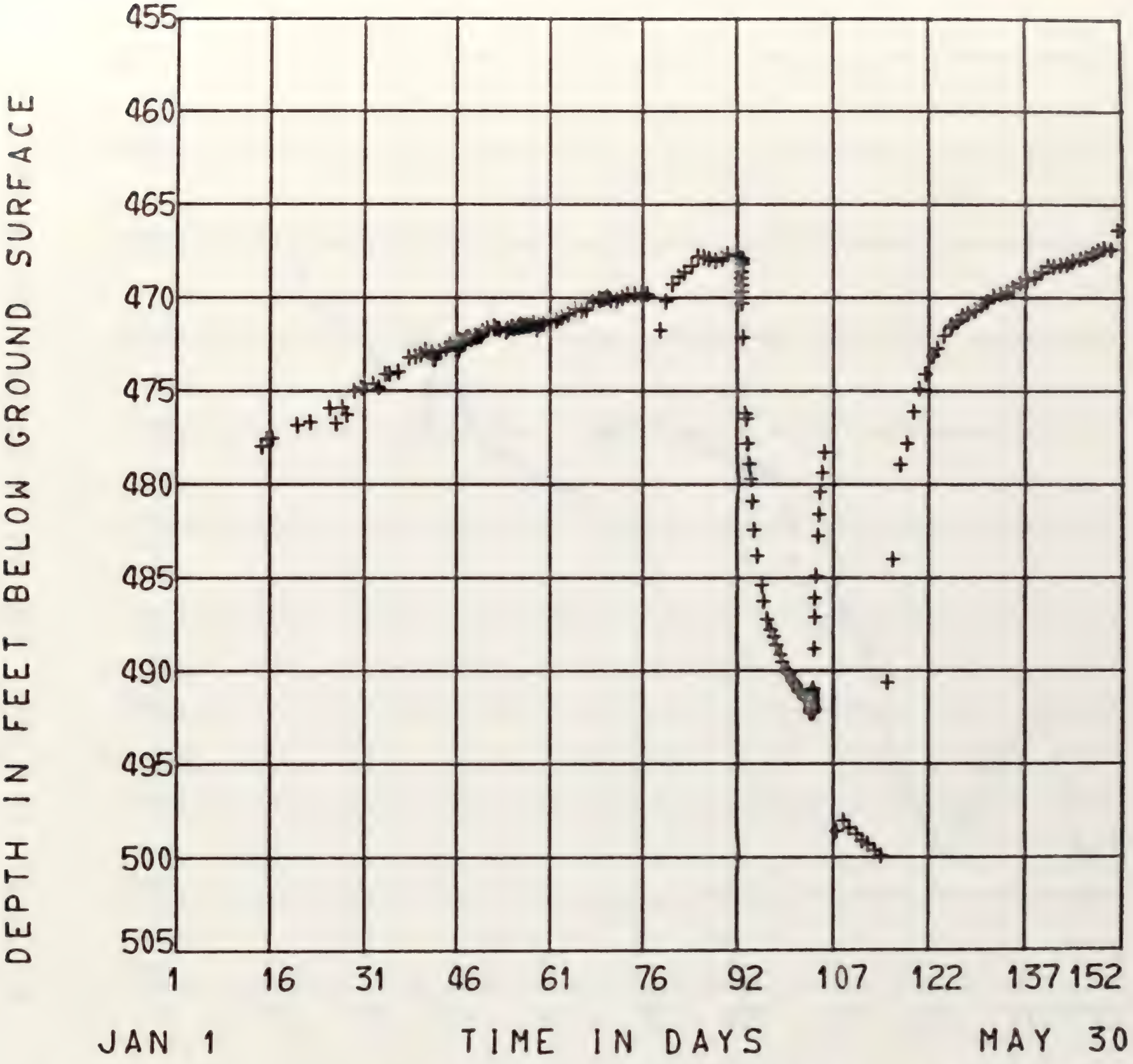
GS-9 HYDROGRAPH LOWR AQUIFER



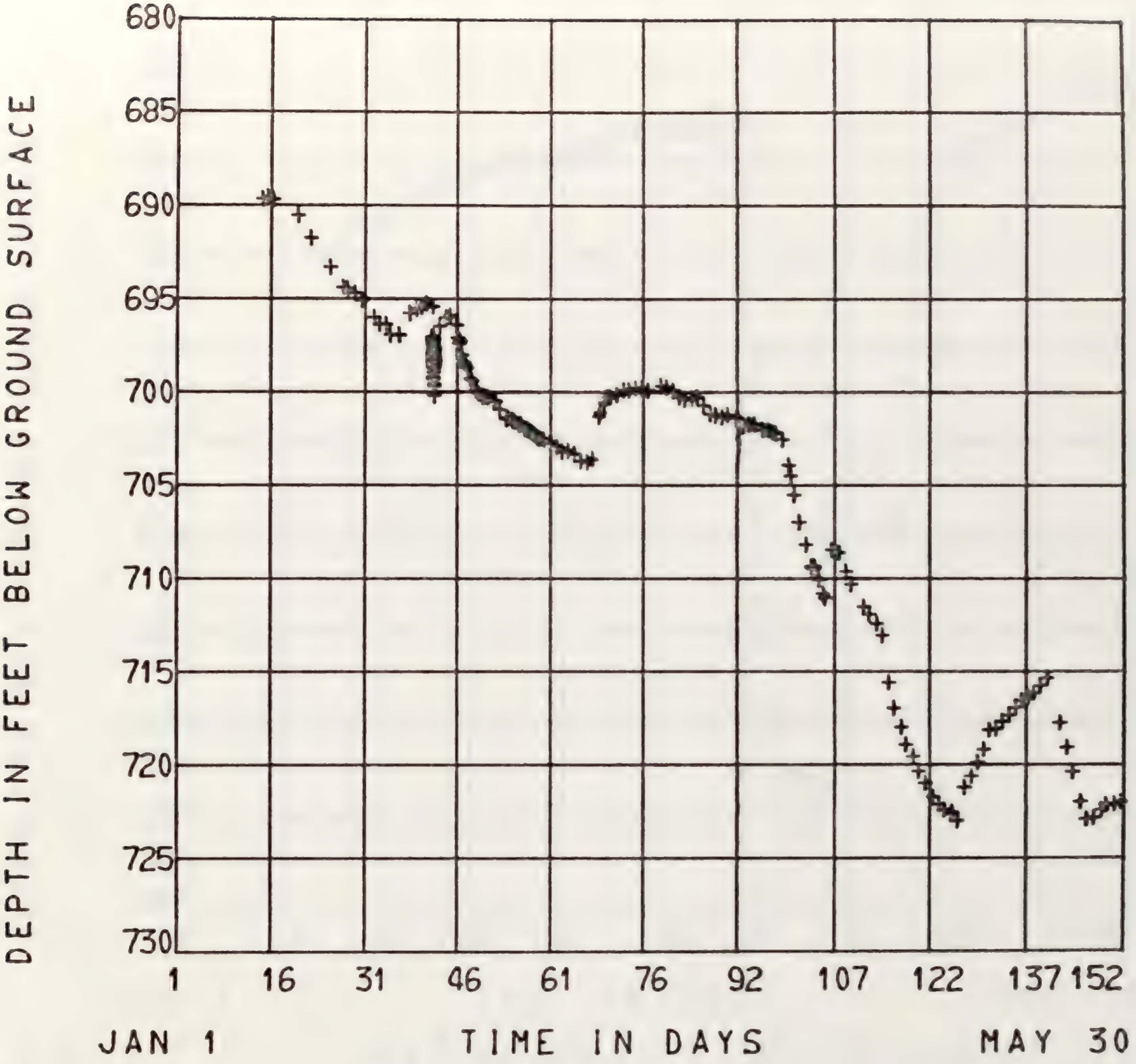
GS-10 HYDROGRAPH UPPR AQUIFER



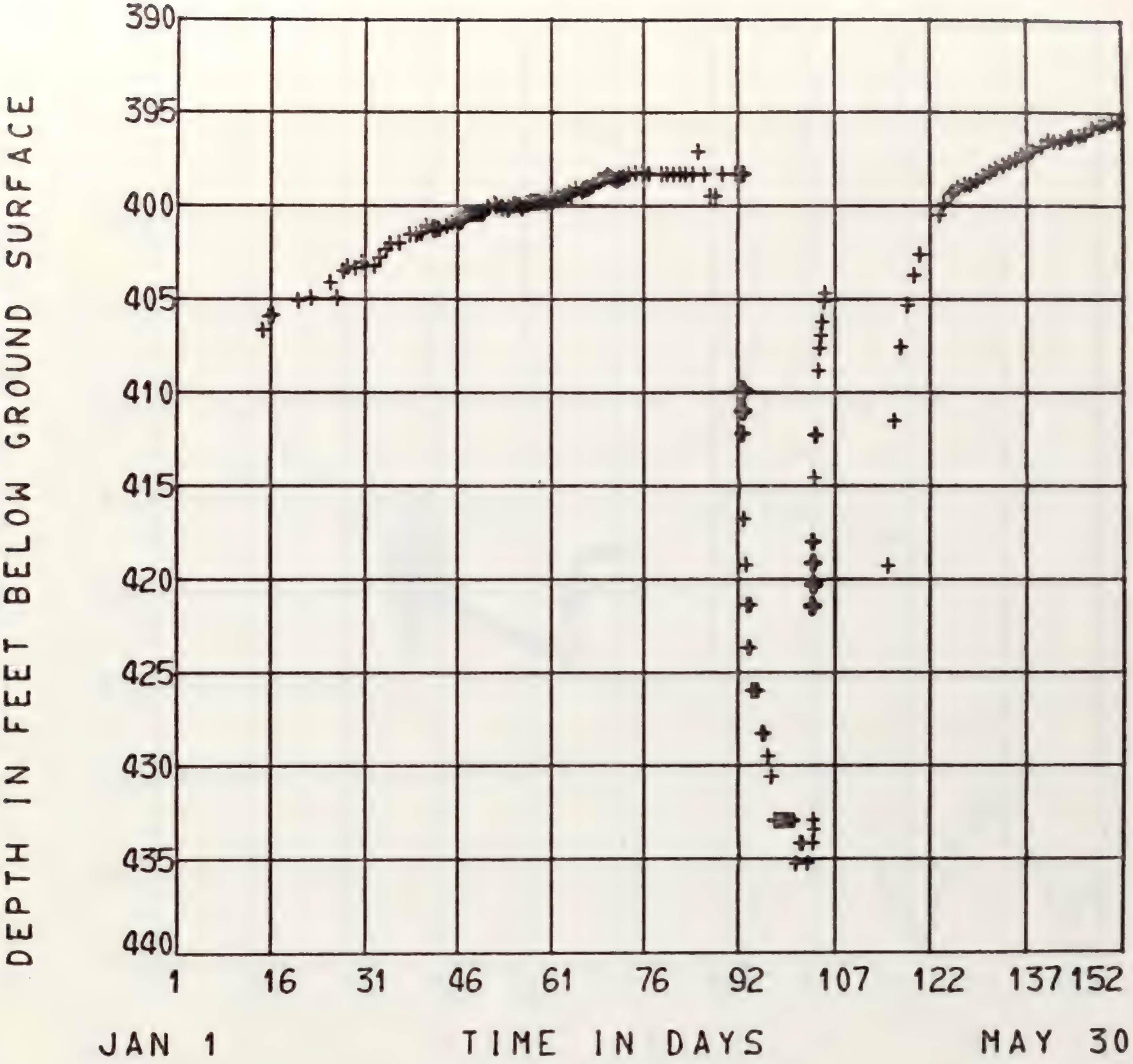
GS-10 HYDROGRAPH LOWR AQUIFER



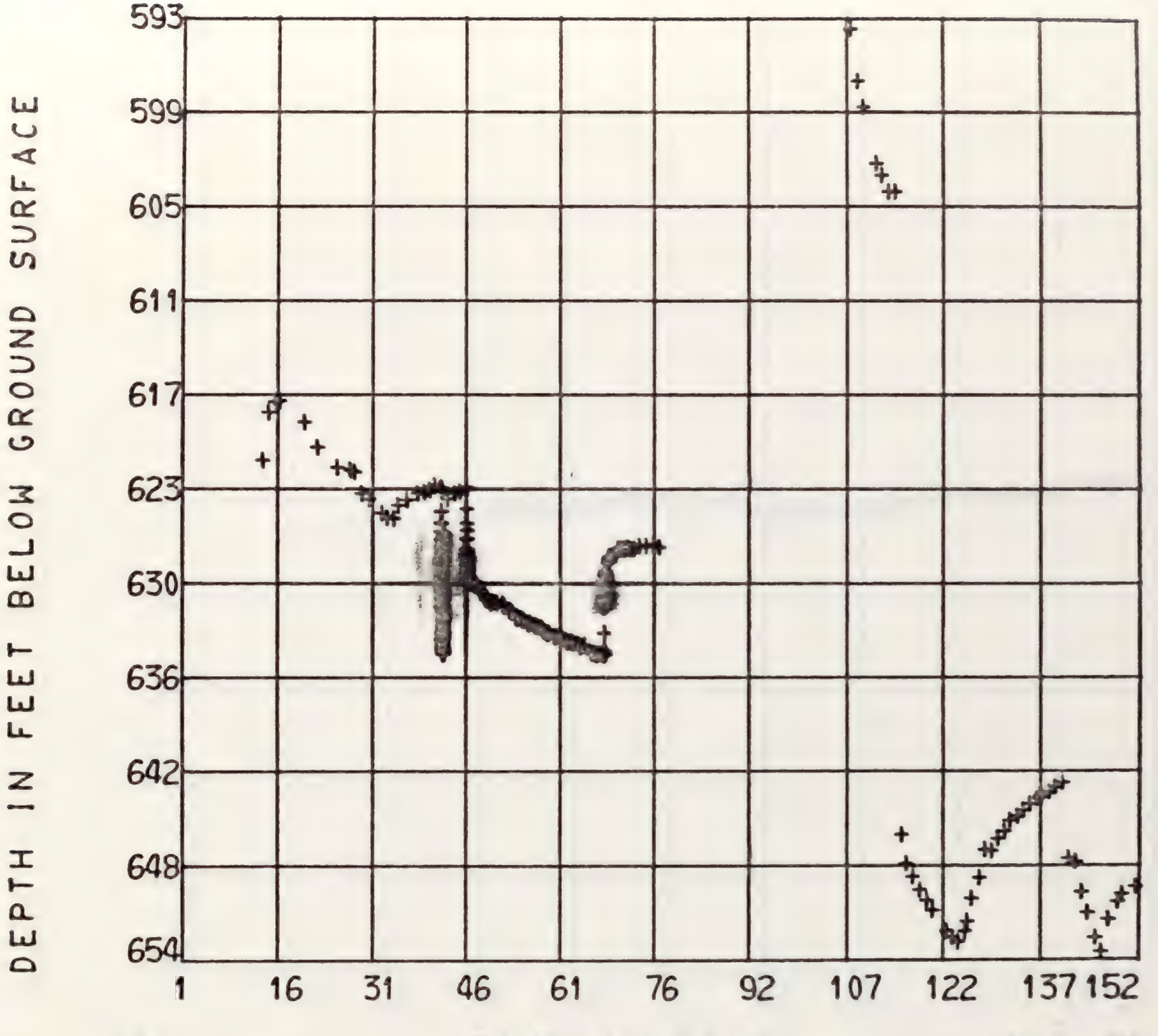
GS-11 HYDROGRAPH UPPR AQUIFER



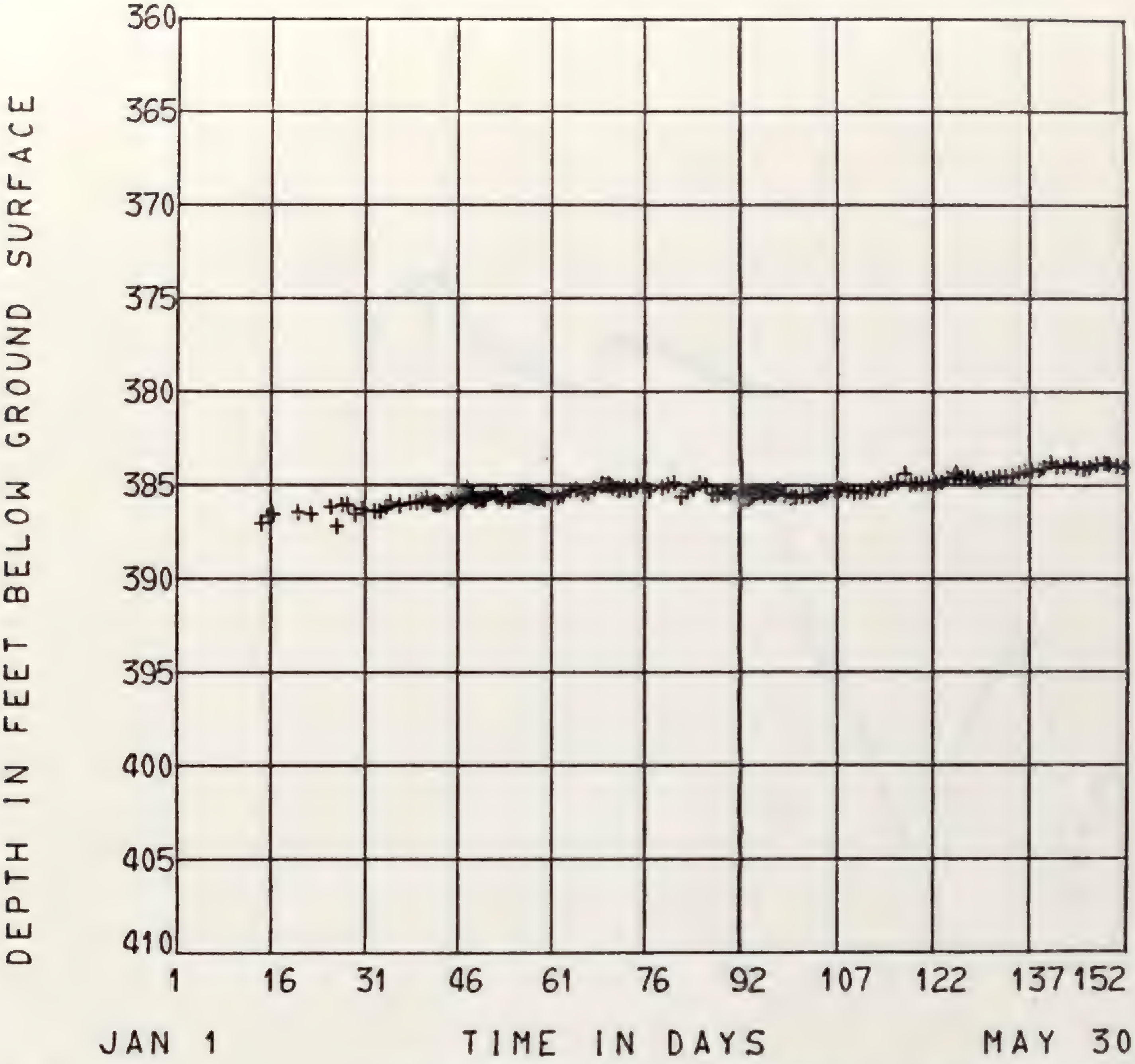
GS-11 HYDROGRAPH LOWR AQUIFER



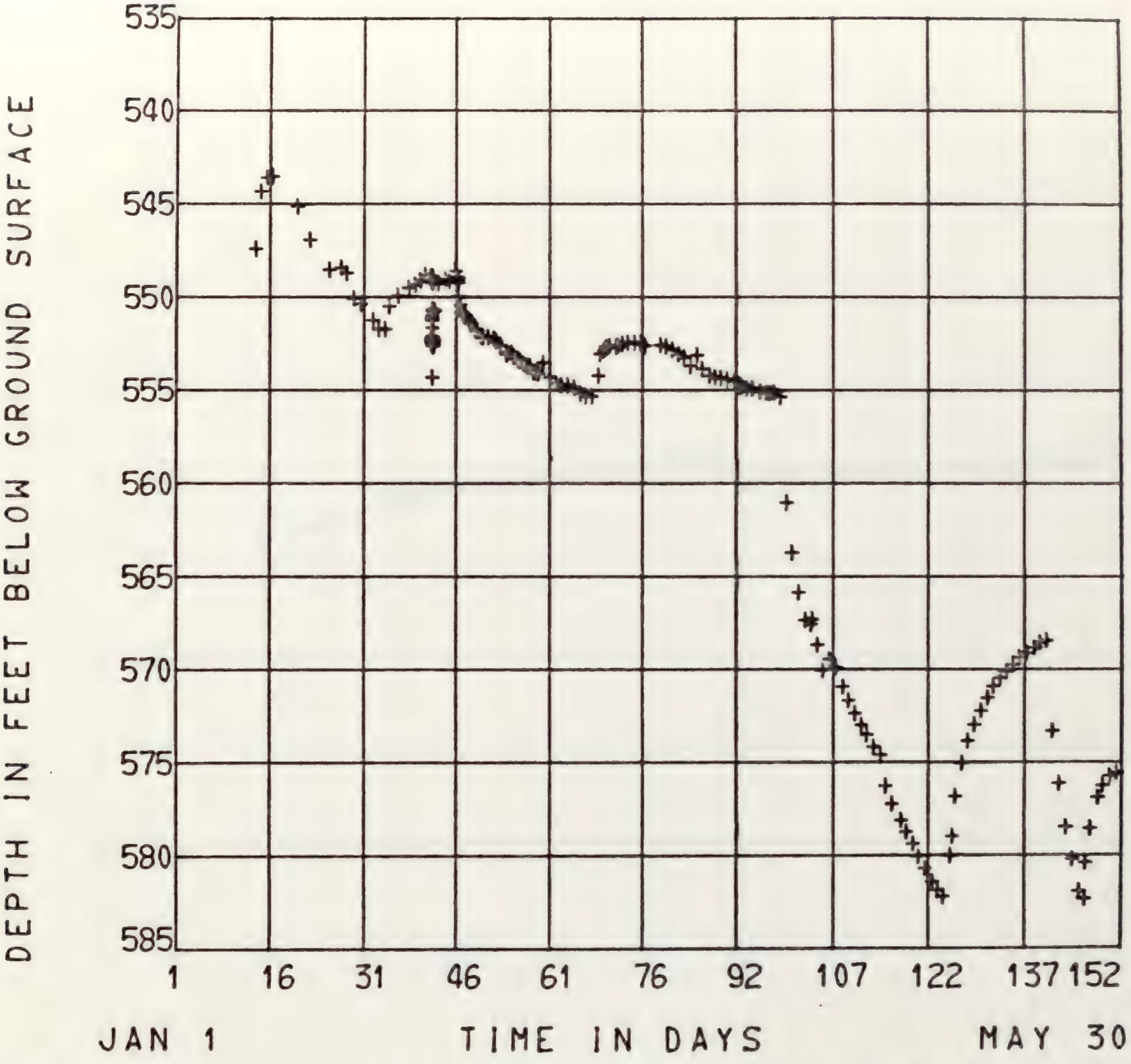
GS-12 HYDROGRAPH UPPR AQUIFER



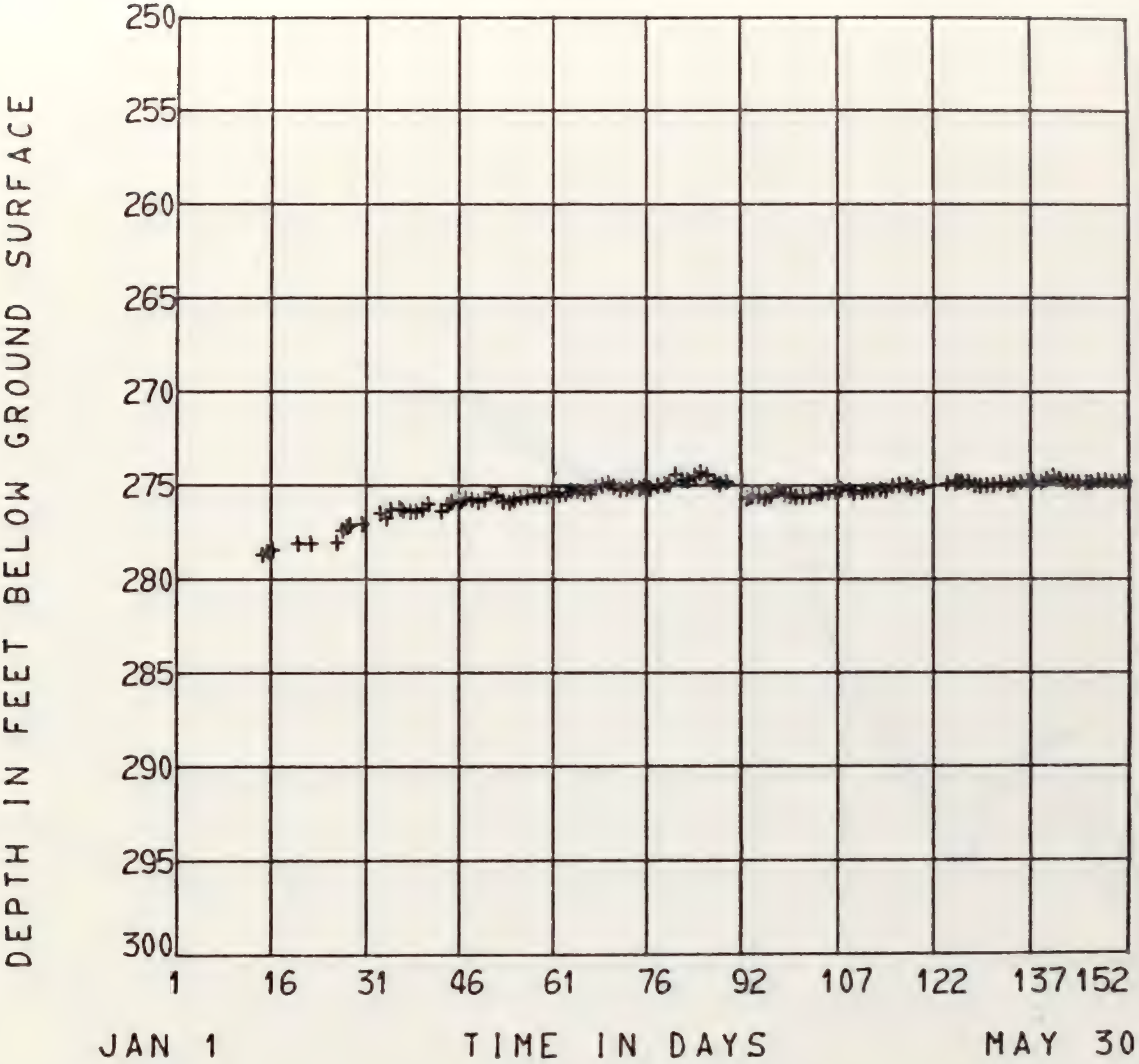
GS-12 HYDROGRAPH LOWR AQUIFER



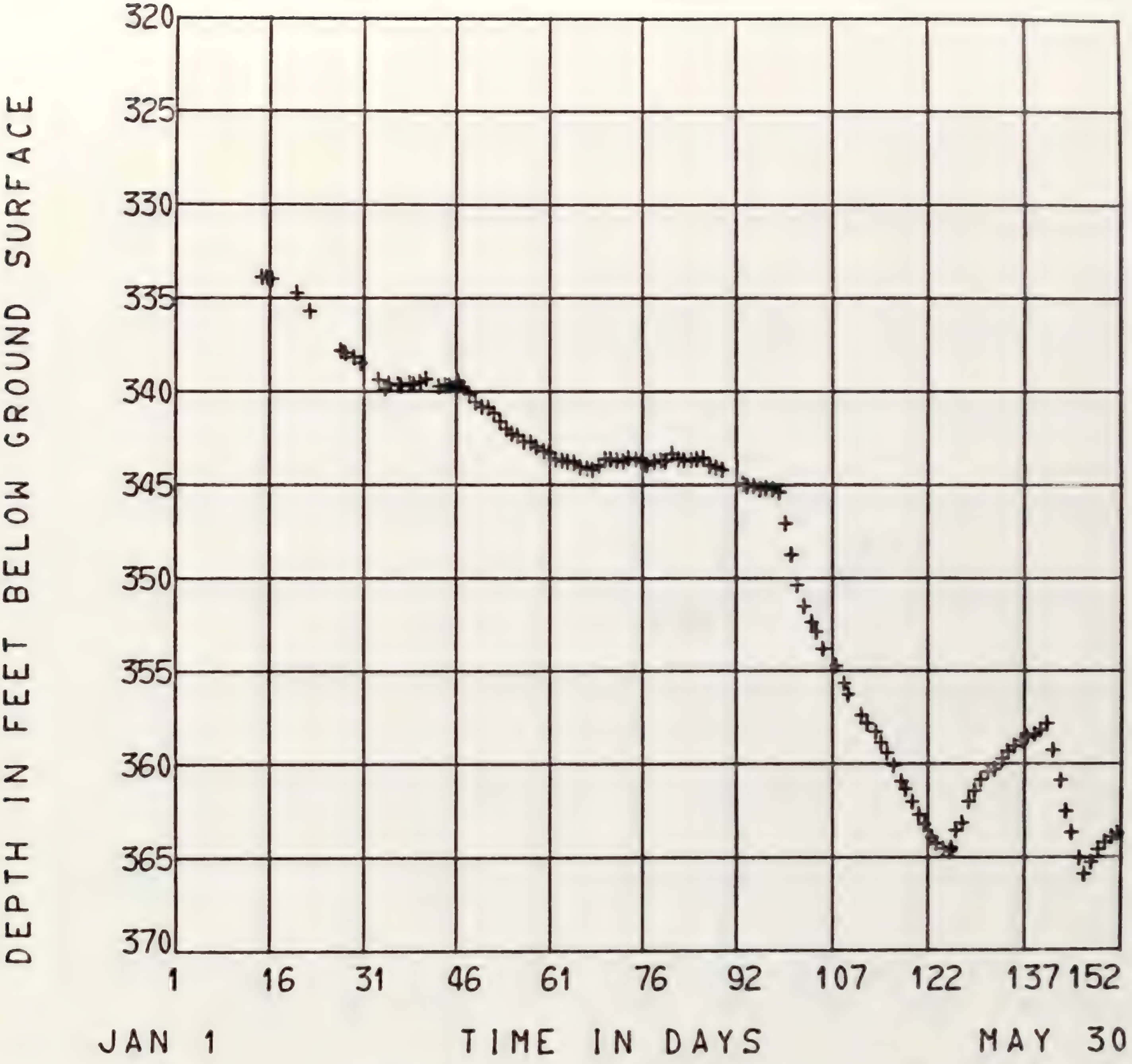
GS-13 HYDROGRAPH UPPR AQUIFER



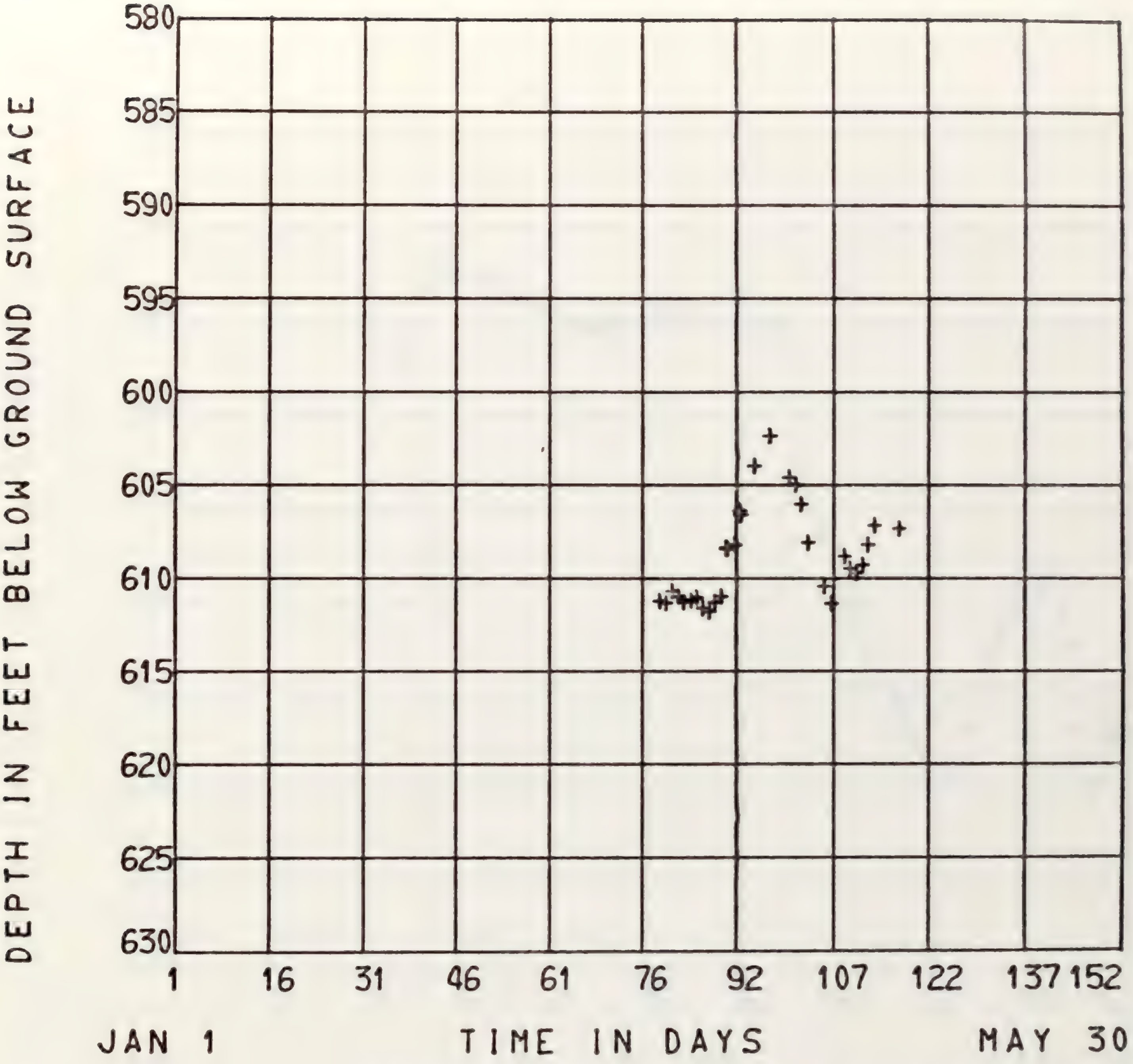
GS-13 HYDROGRAPH LOWR AQUIFER



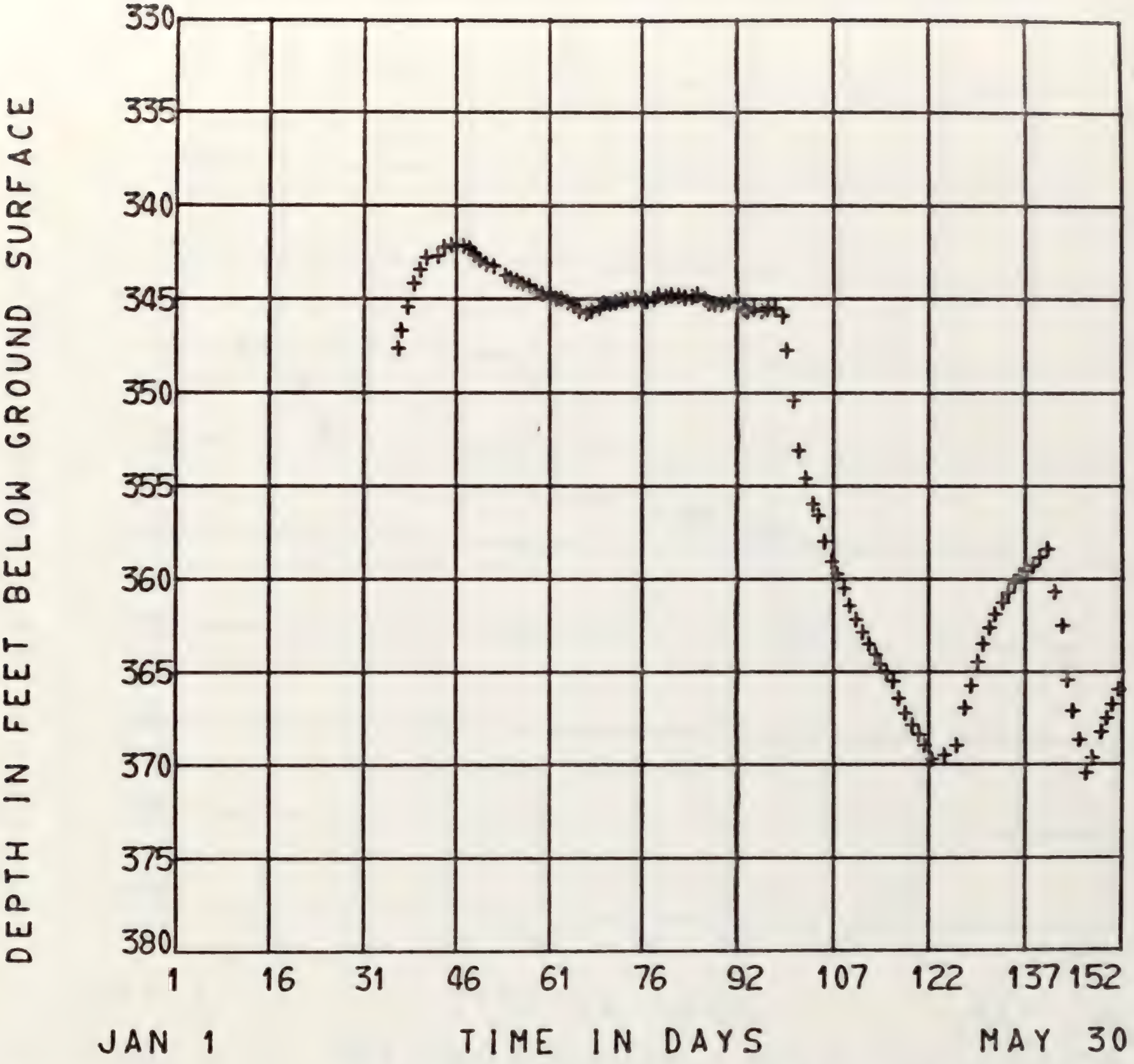
GS-15 HYDROGRAPH UPPR AQUIFER



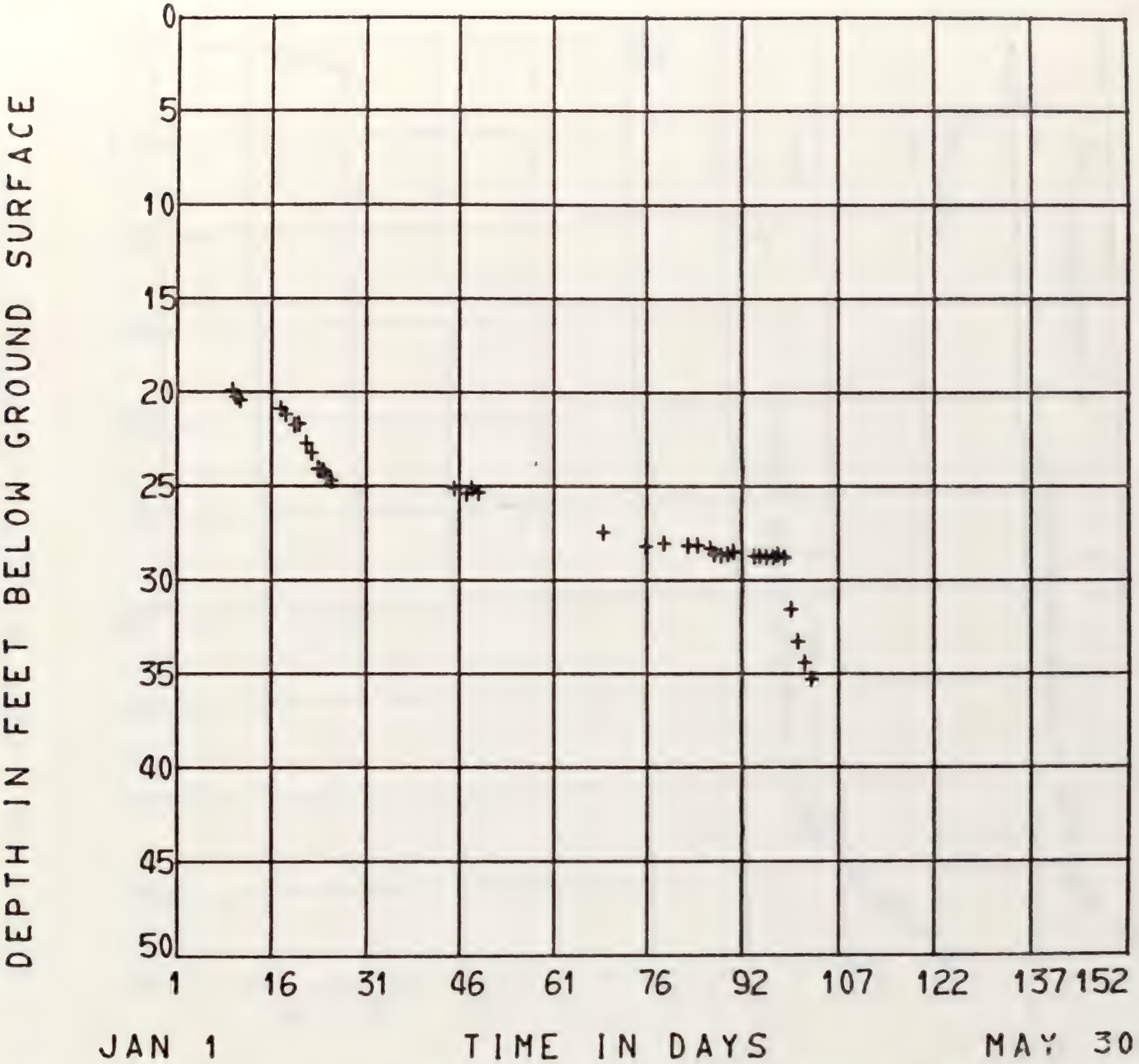
GS-15 HYDROGRAPH LOWR AQUIFER



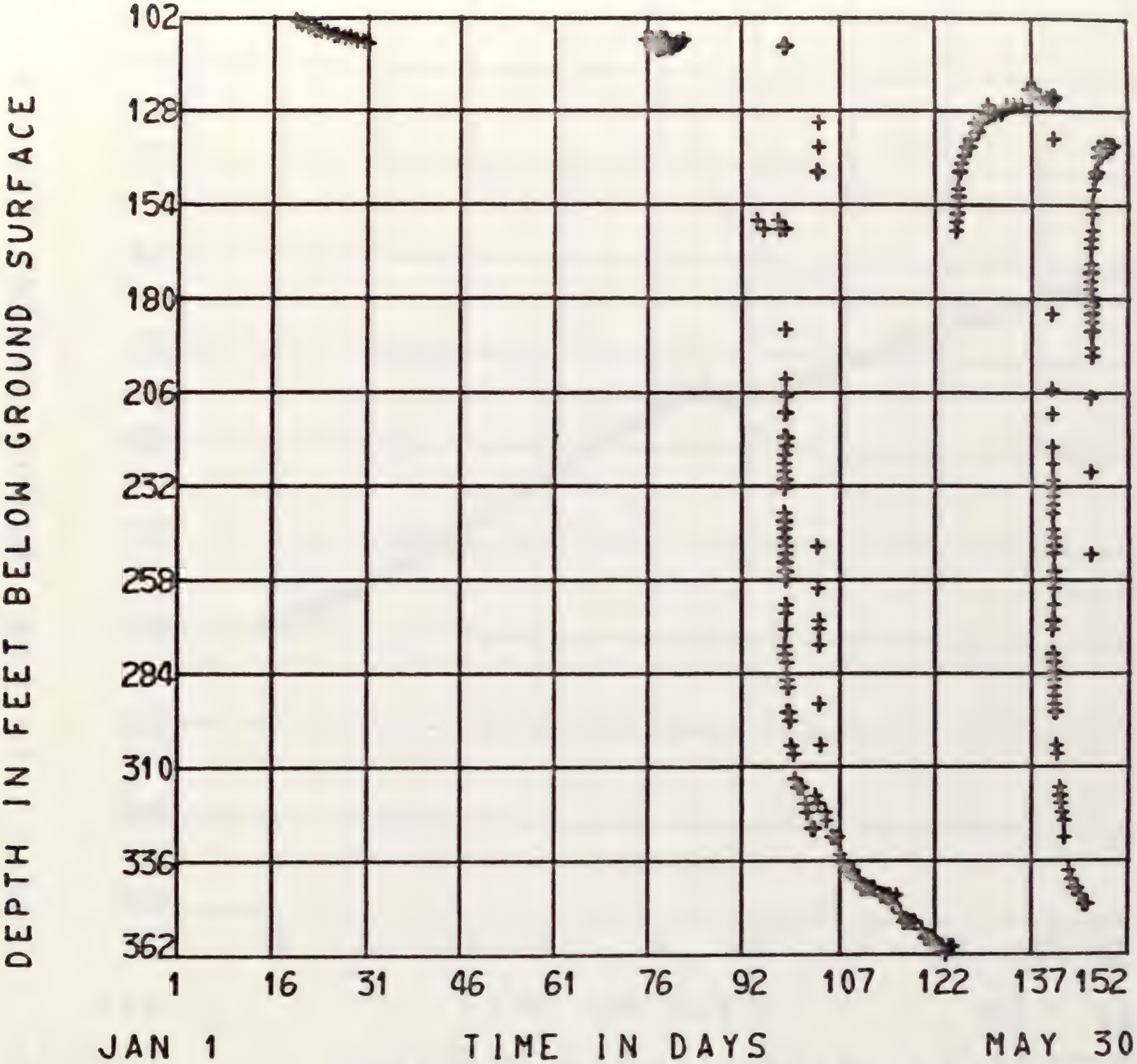
GS-16 HYDROGRAPH LOWR AQUIFER



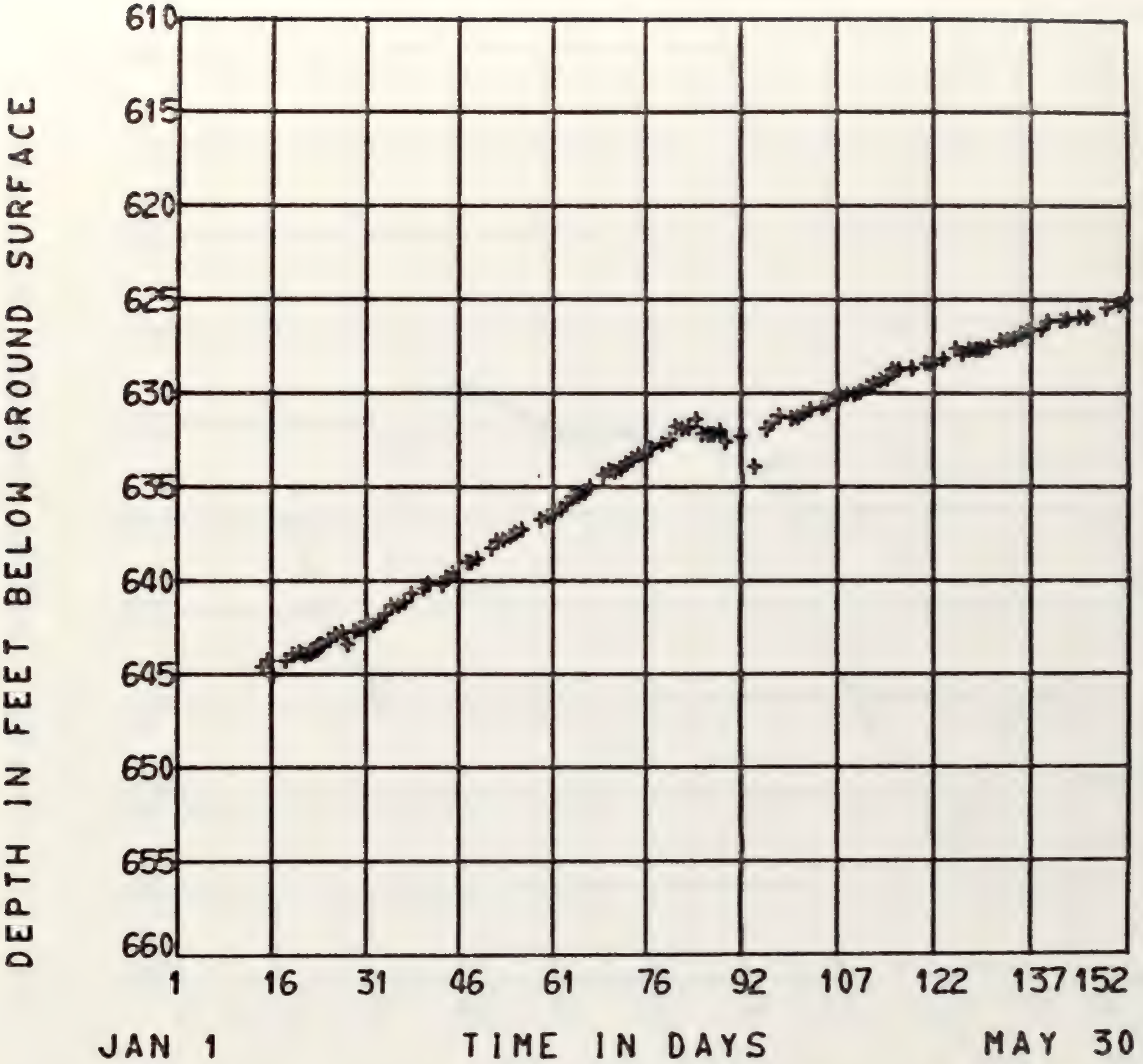
GS-17 HYDROGRAPH LOWR AQUIFER



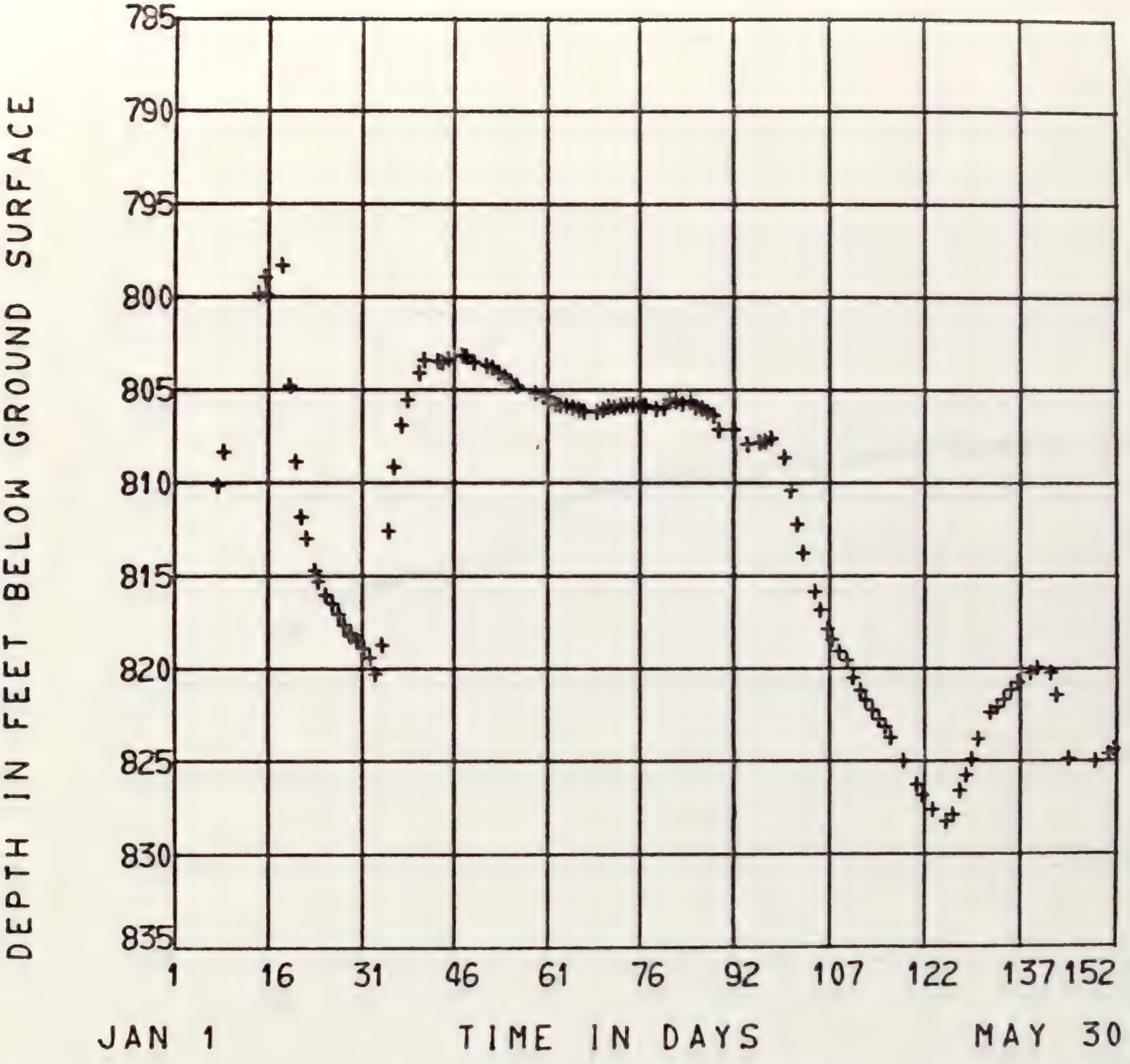
GS-18 HYDROGRAPH LOWR AQUIFER



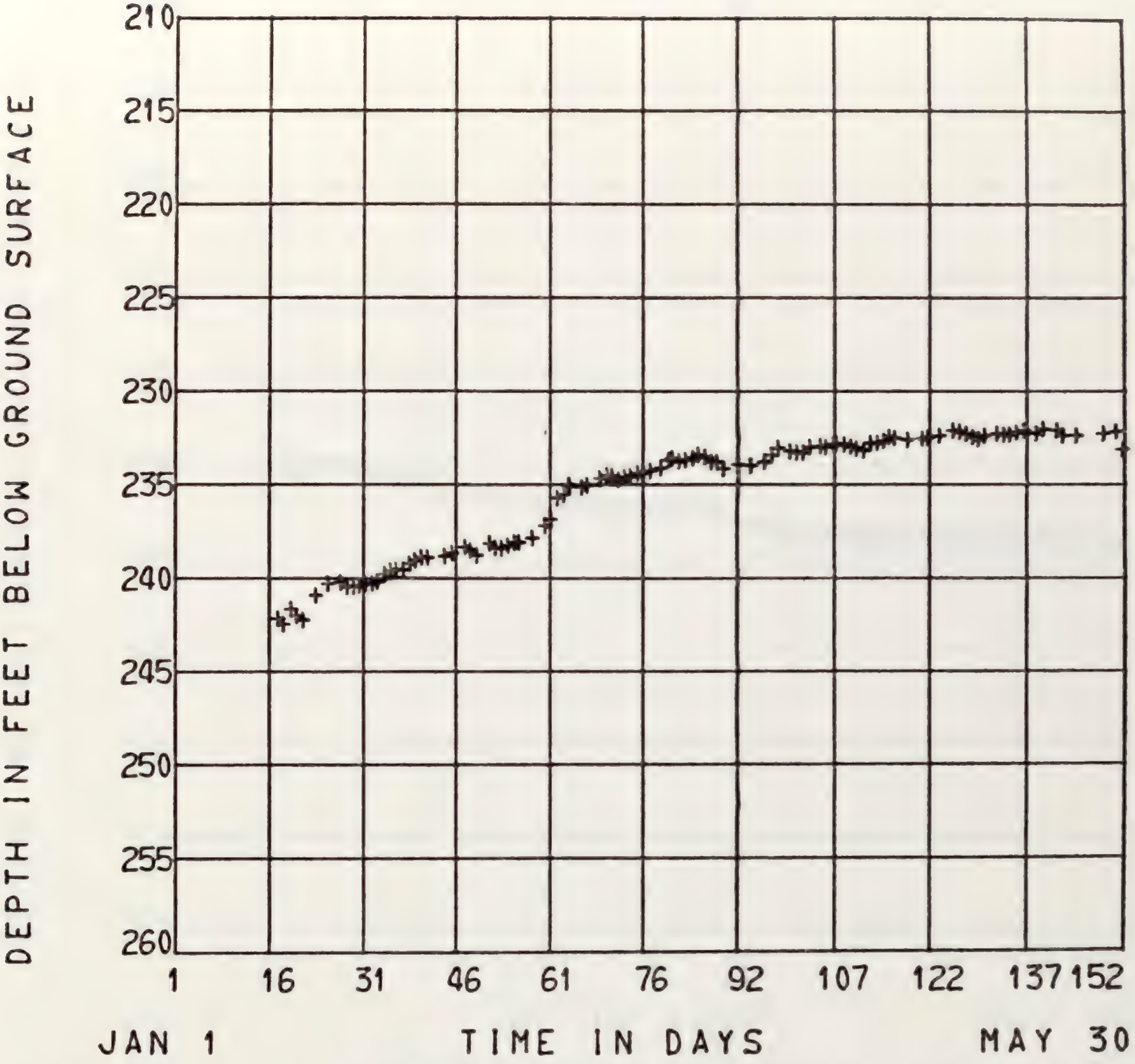
GS-19 HYDROGRAPH LOWR AQUIFER



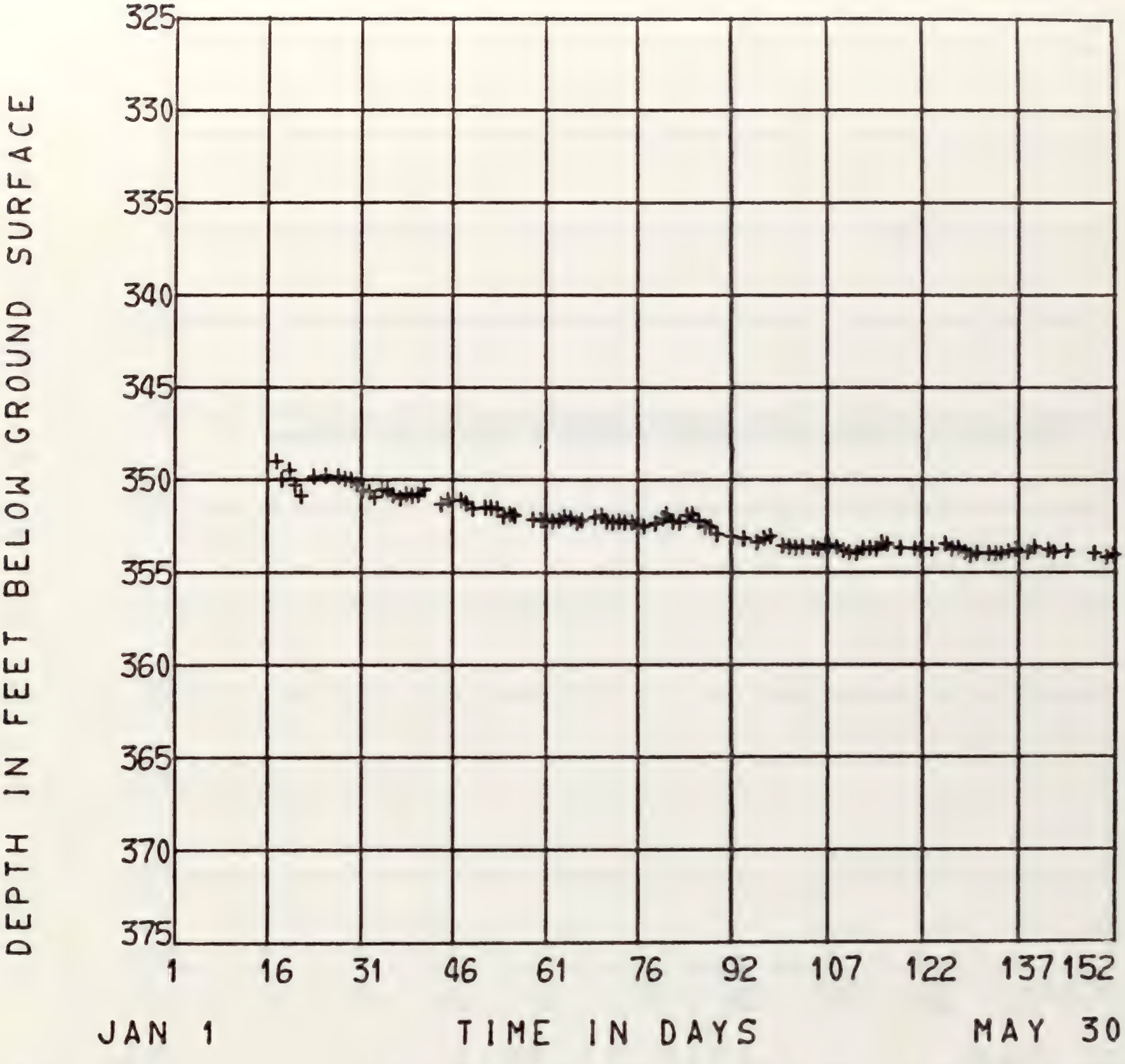
GSM-1 HYDROGRAPH UPPR AQUIFER



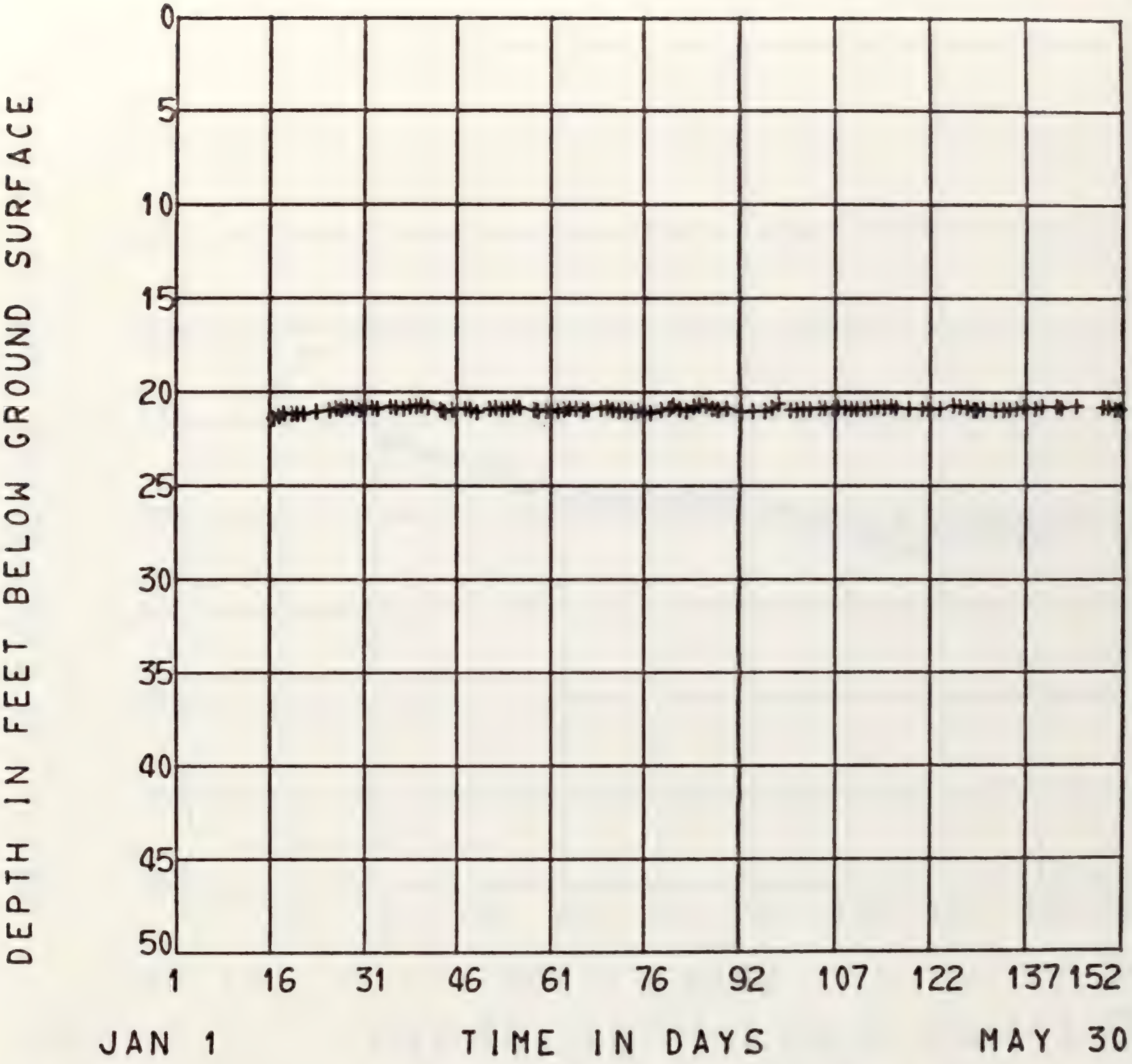
GSM-1 HYDROGRAPH LOWR AQUIFER



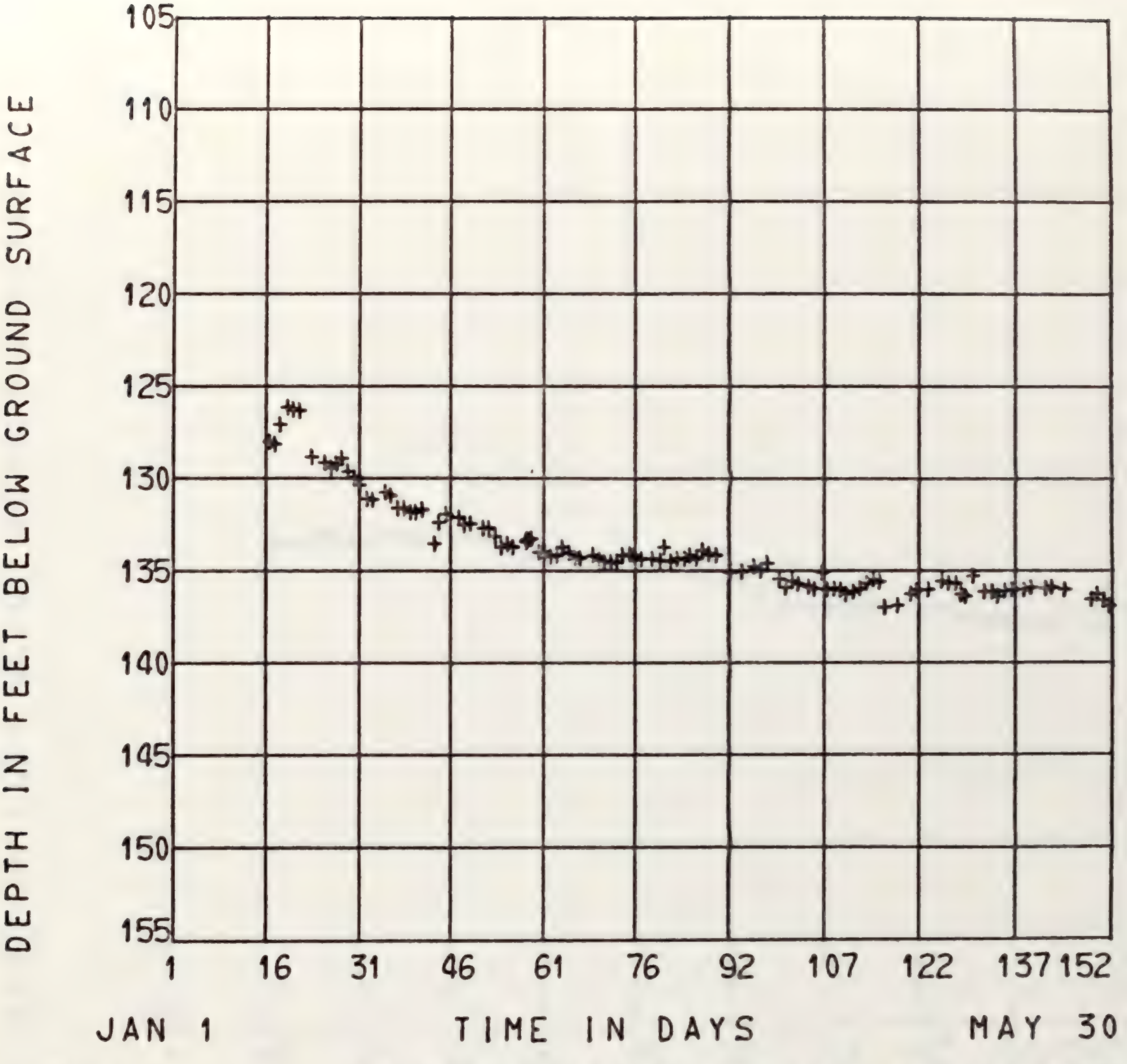
GSM-2 HYDROGRAPH UPPR AQUIFER



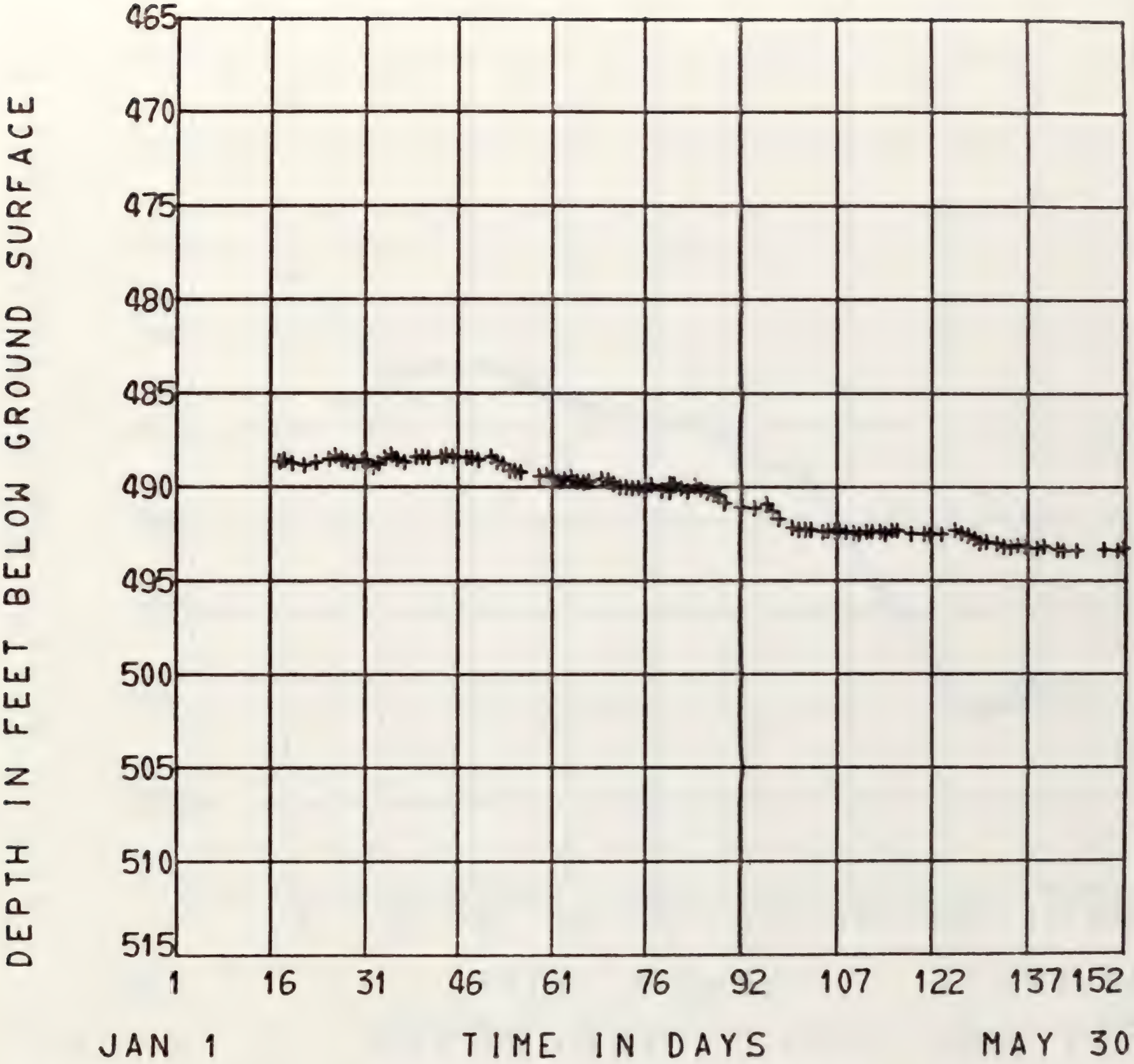
GSM-2 HYDROGRAPH LOWR AQUIFER



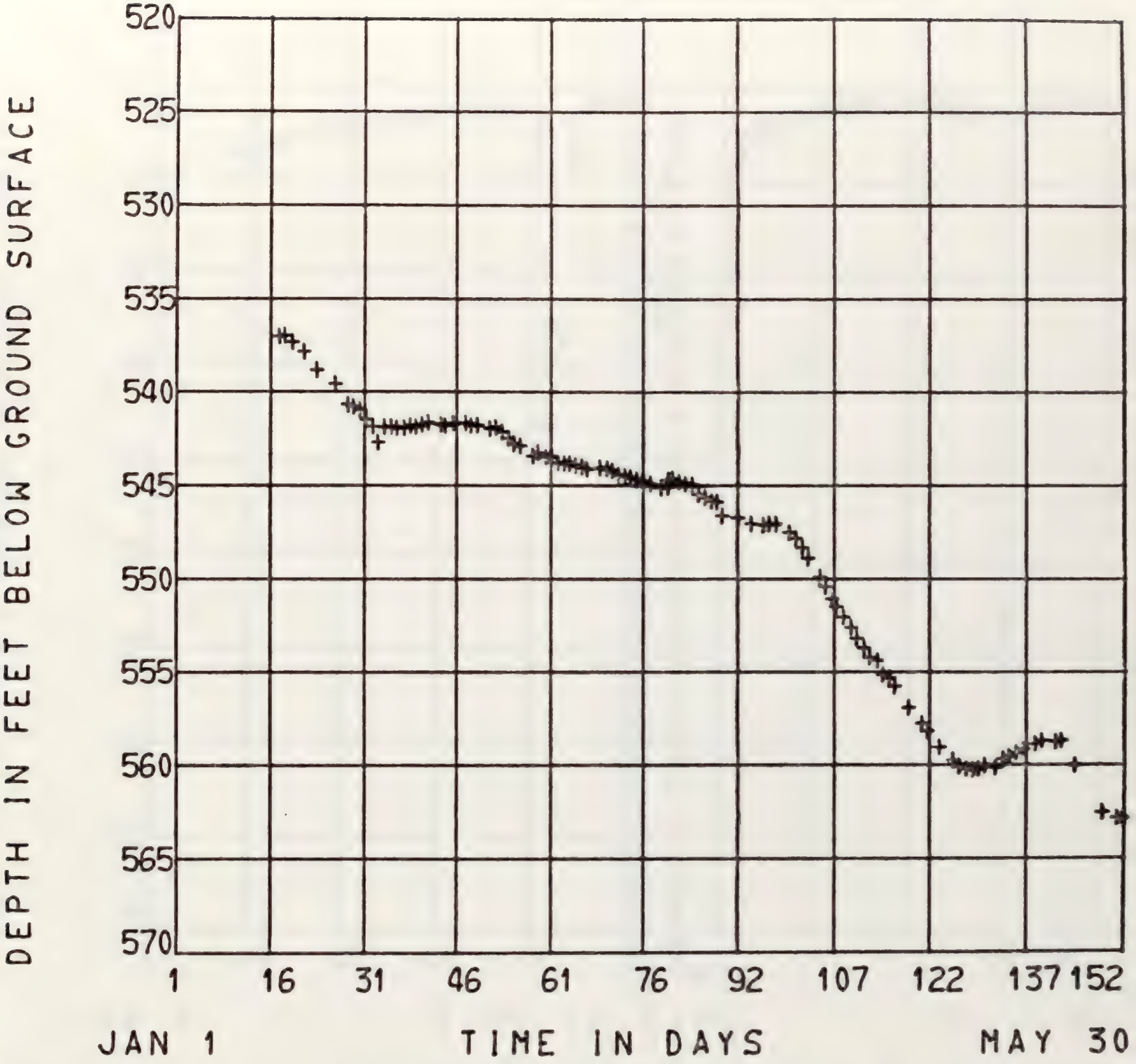
GSM-3 HYDROGRAPH UPPR AQUIFER



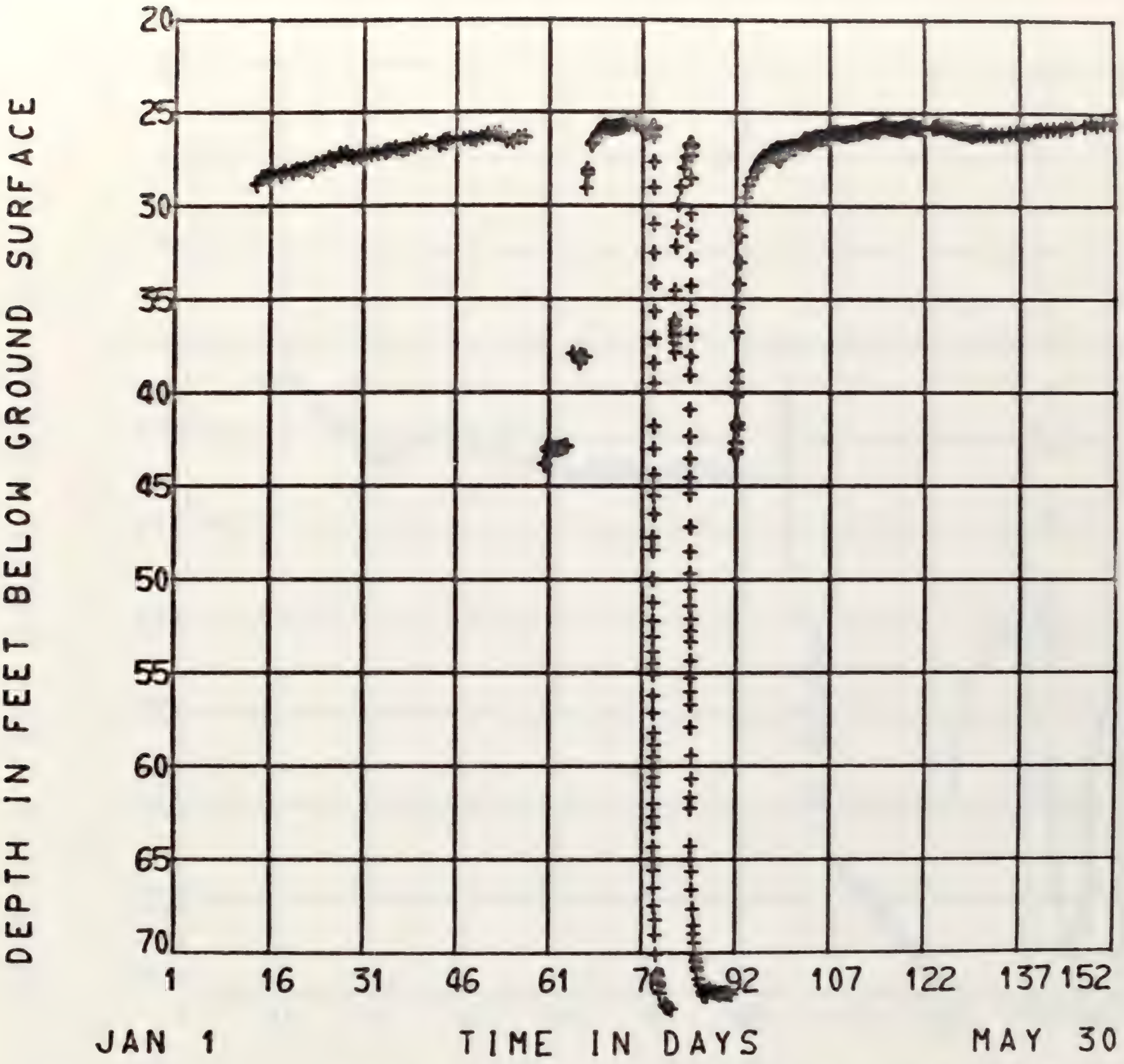
GSM-3 HYDROGRAPH LOWR AQUIFER



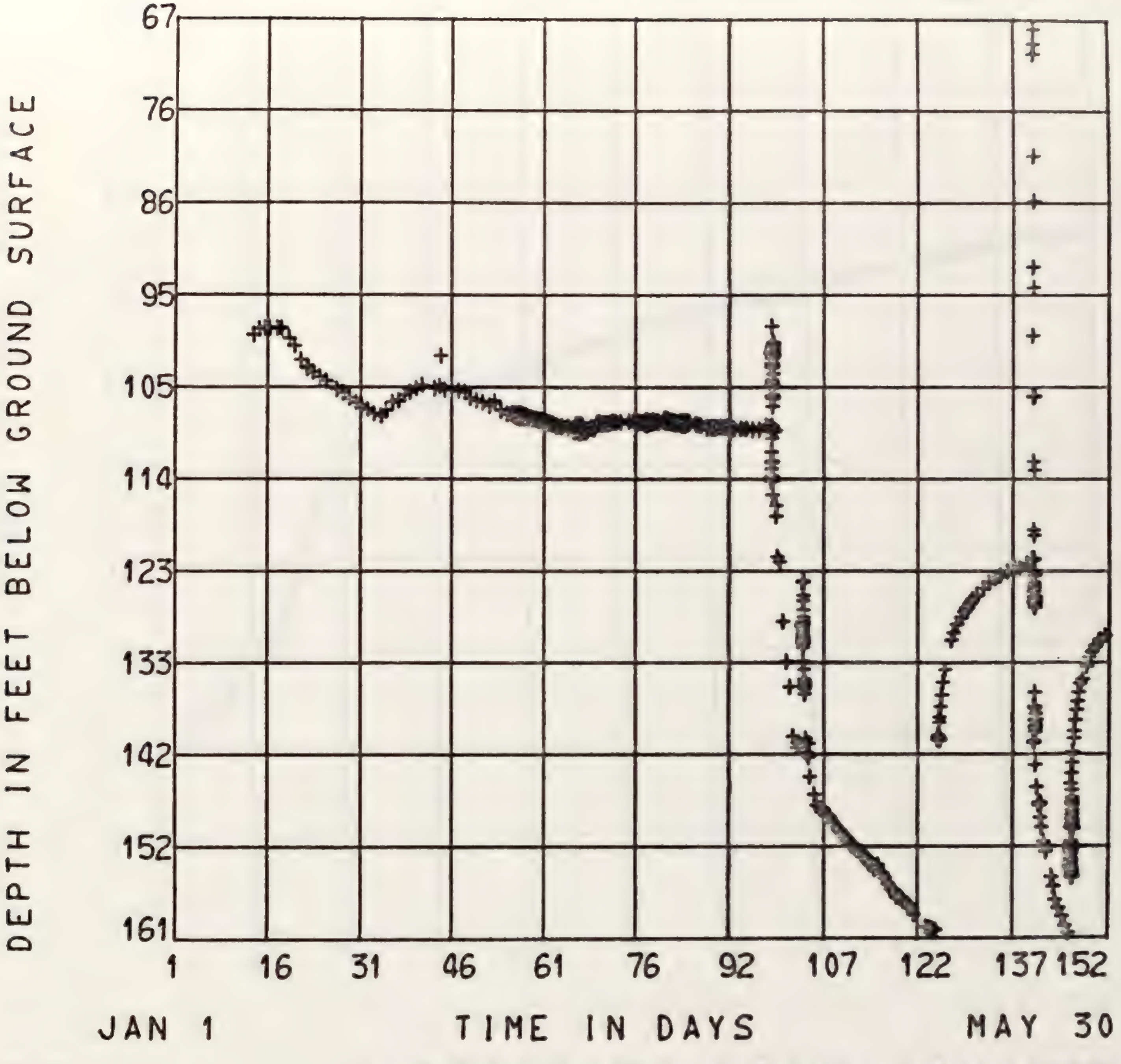
GSM-4 HYDROGRAPH UPPR AQUIFER



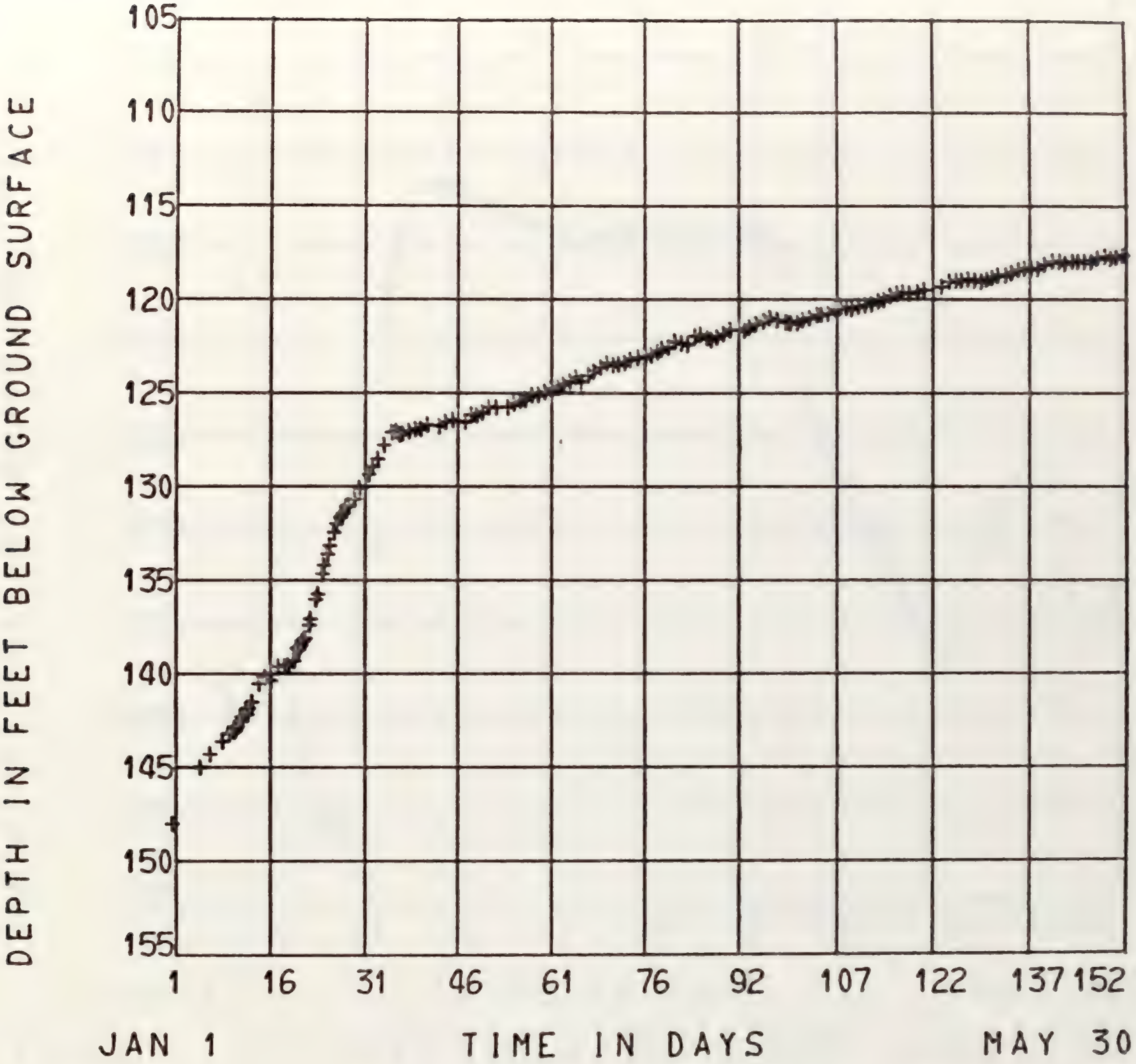
GSM-4 HYDROGRAPH LOWR AQUIFER



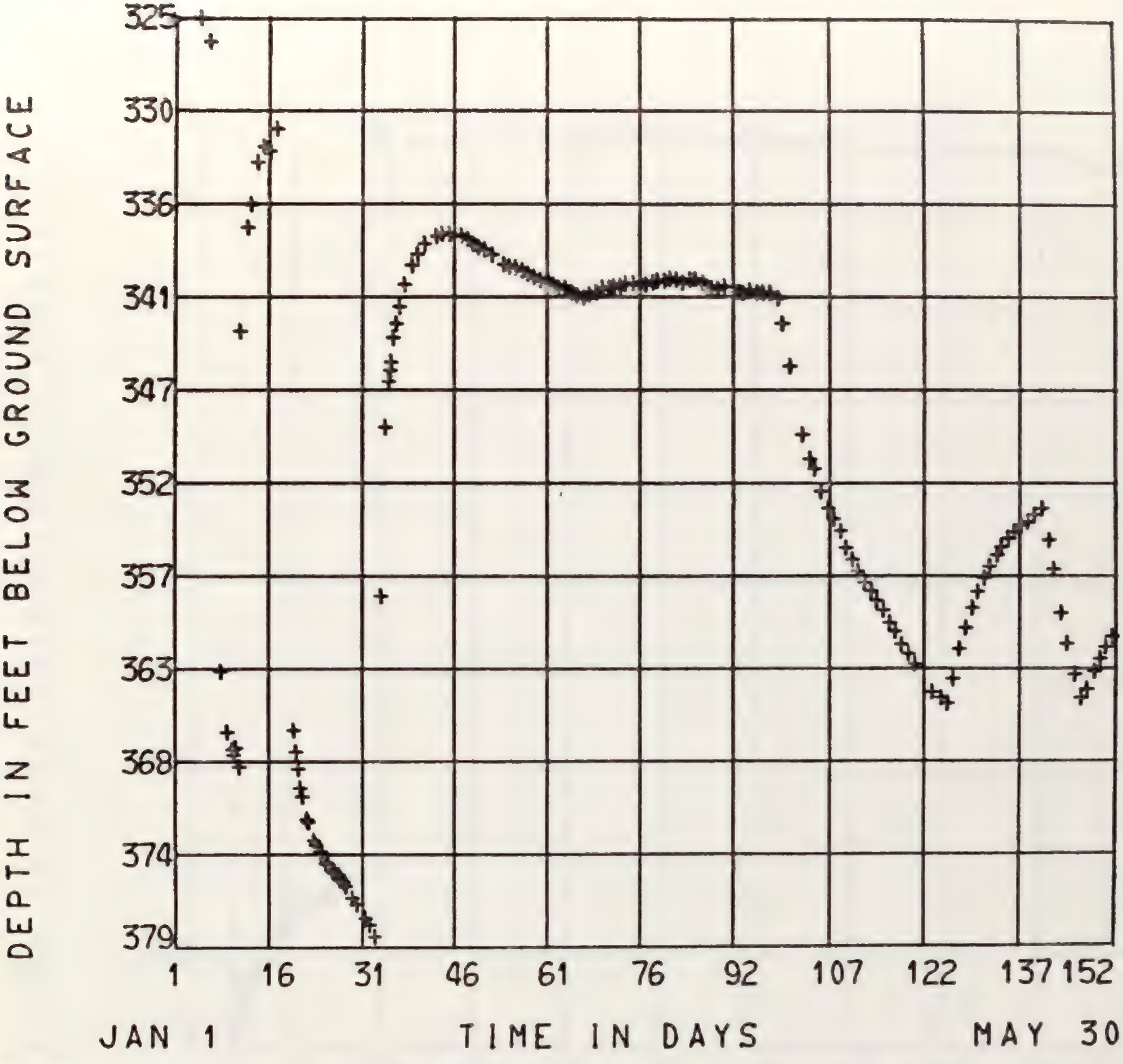
TO-1 HYDROGRAPH UPPR AQUIFER



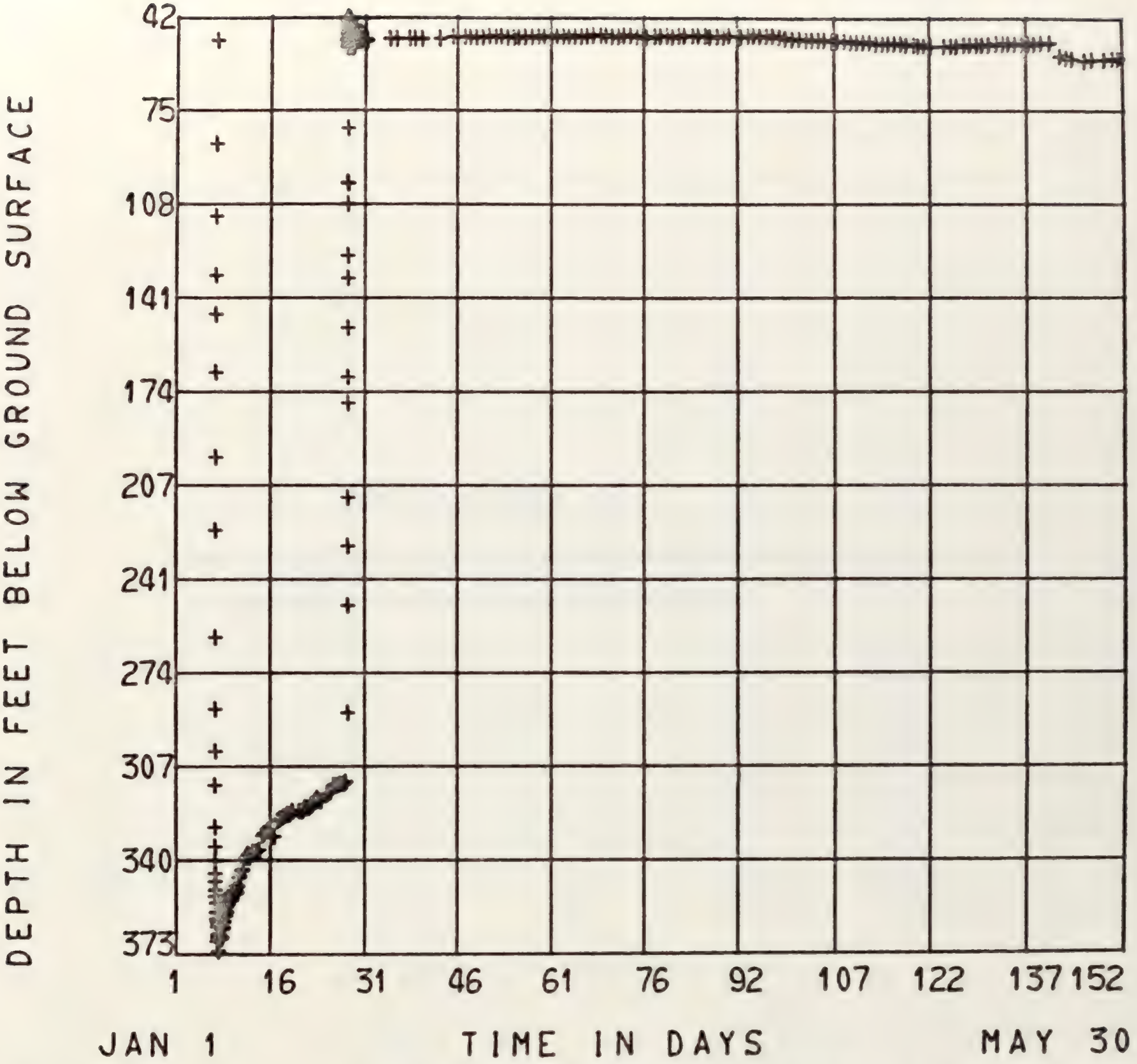
TO-1 HYDROGRAPH LOWR AQUIFER



TO-2 HYDROGRAPH UPPR AQUIFER



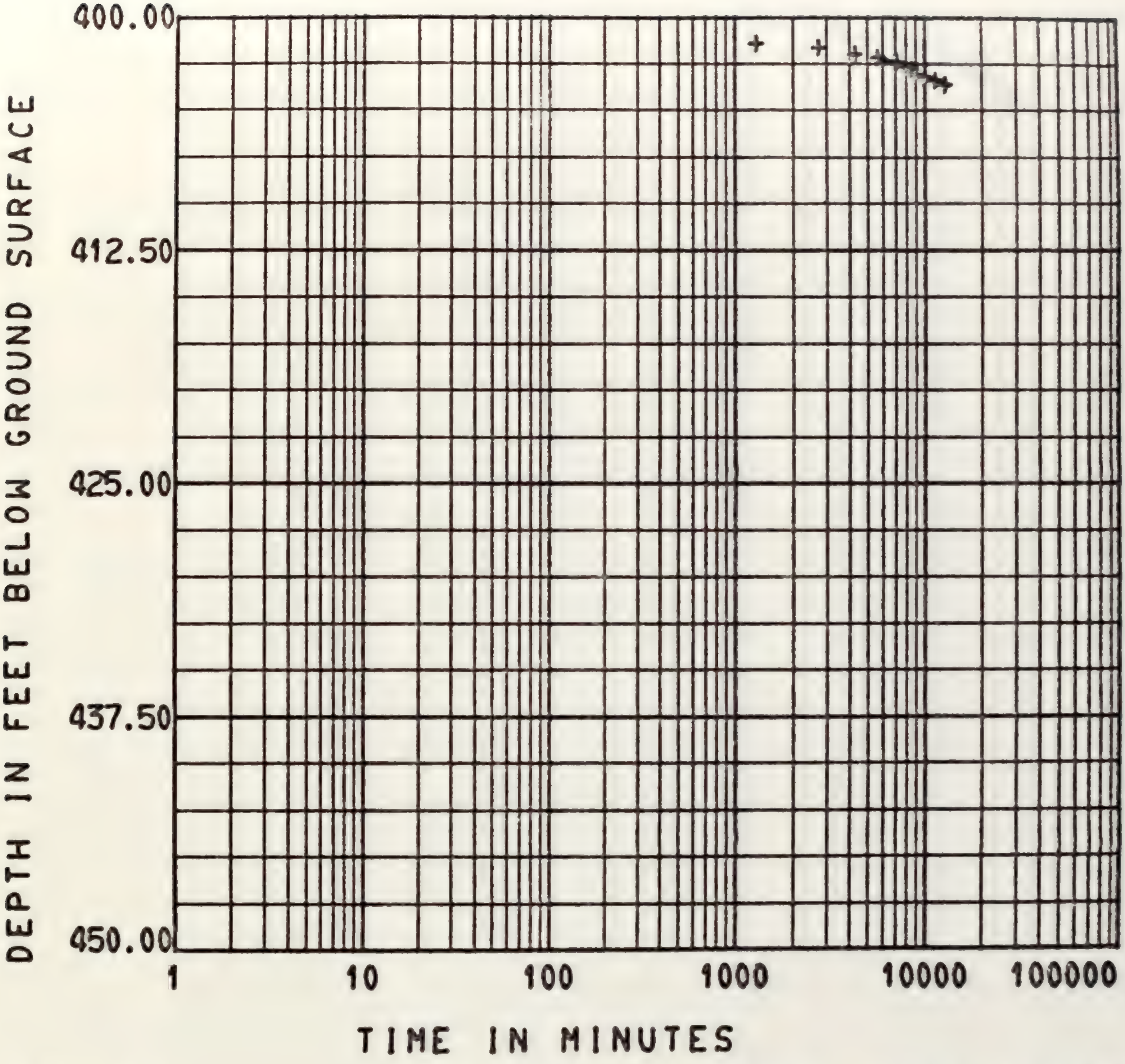
TO-2 HYDROGRAPH LOWR AQUIFER



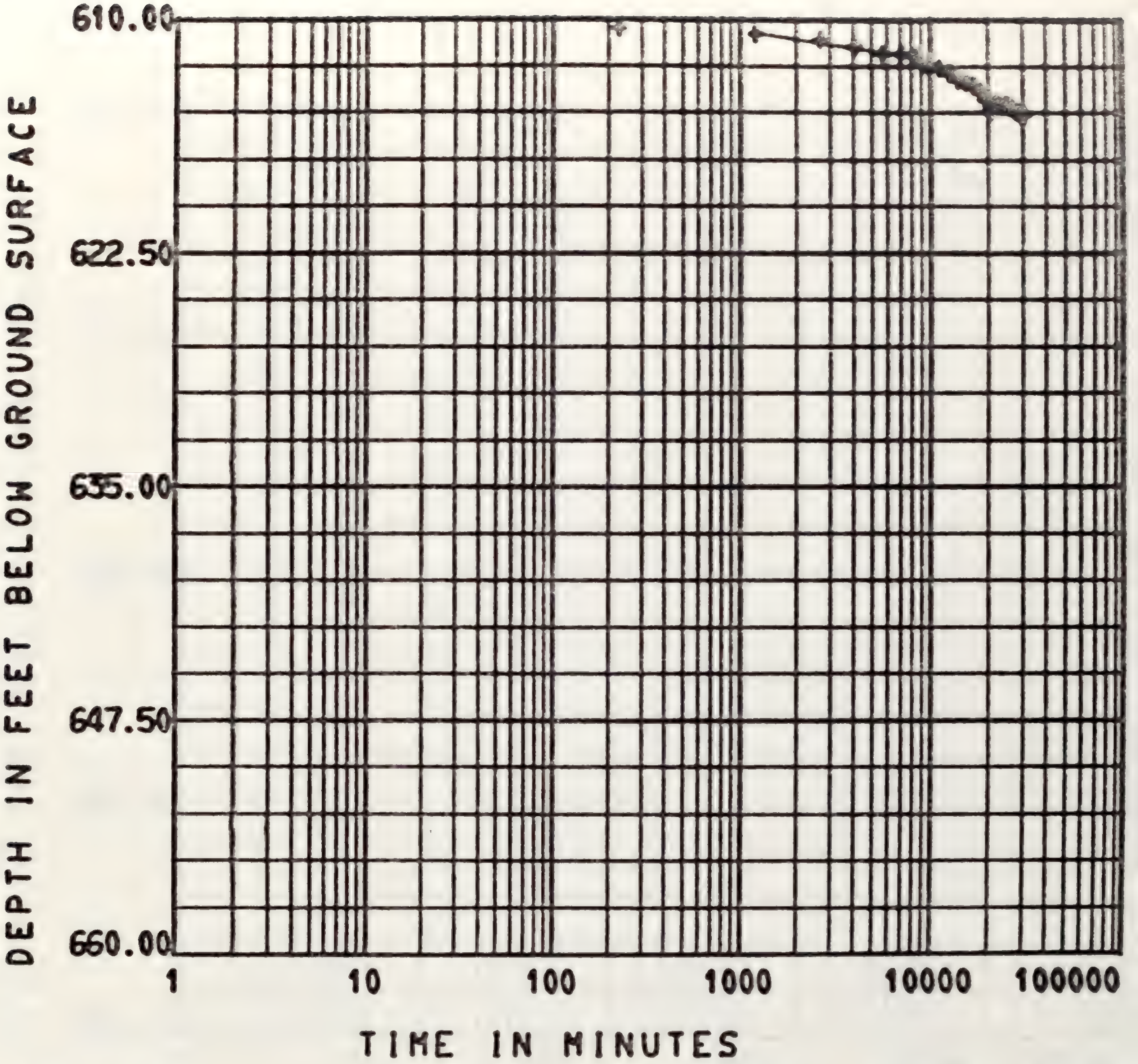
TO-3 HYDROGRAPH UPPR AQUIFER

SIMPLIFIED JACOBS PLOTS

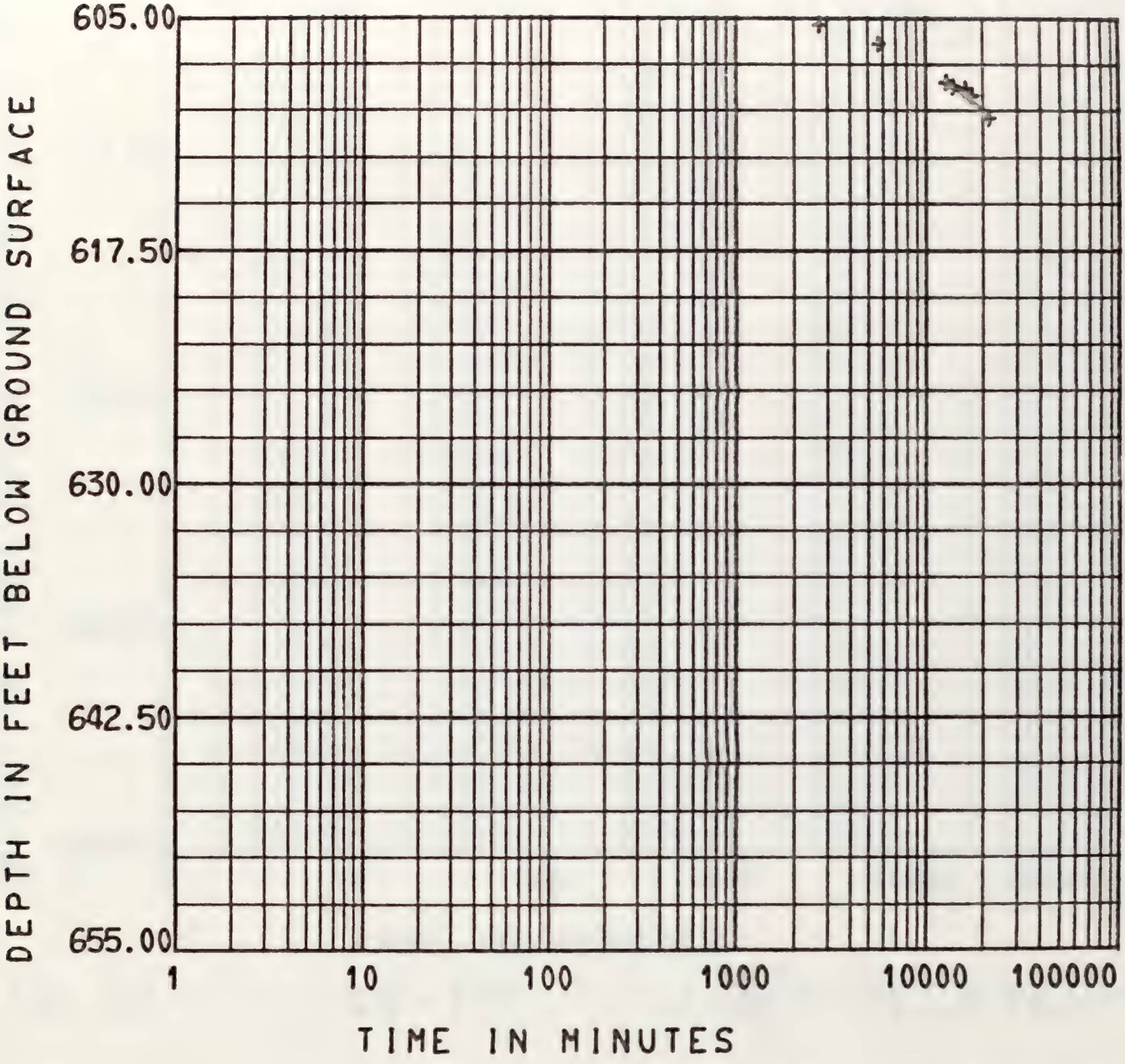
Pumping Test Holes and Deep Aquifer Monitor Holes Responding To Individual Pumping Tests



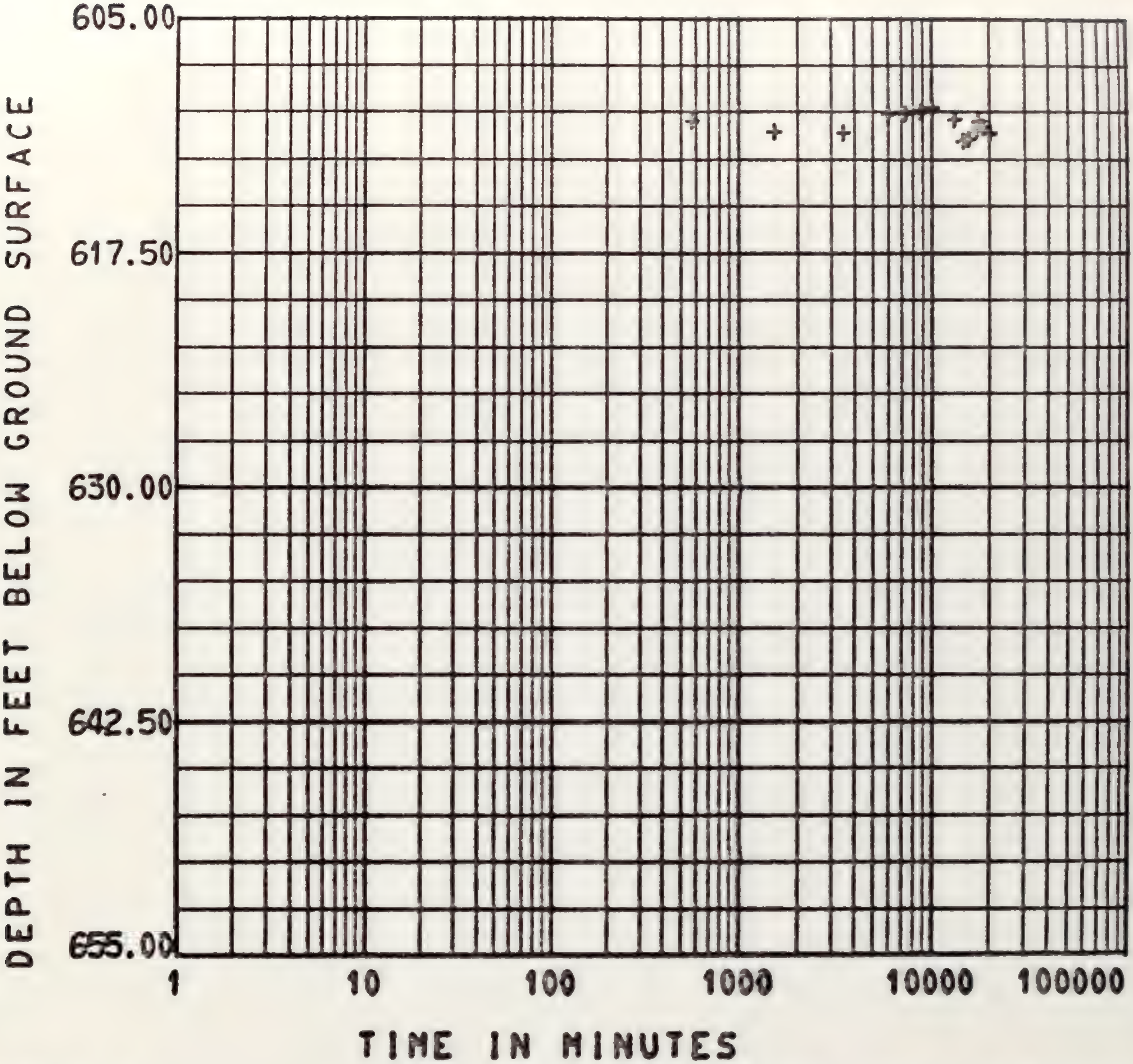
AM-2A GS-12 UPPR DRAWDOWN



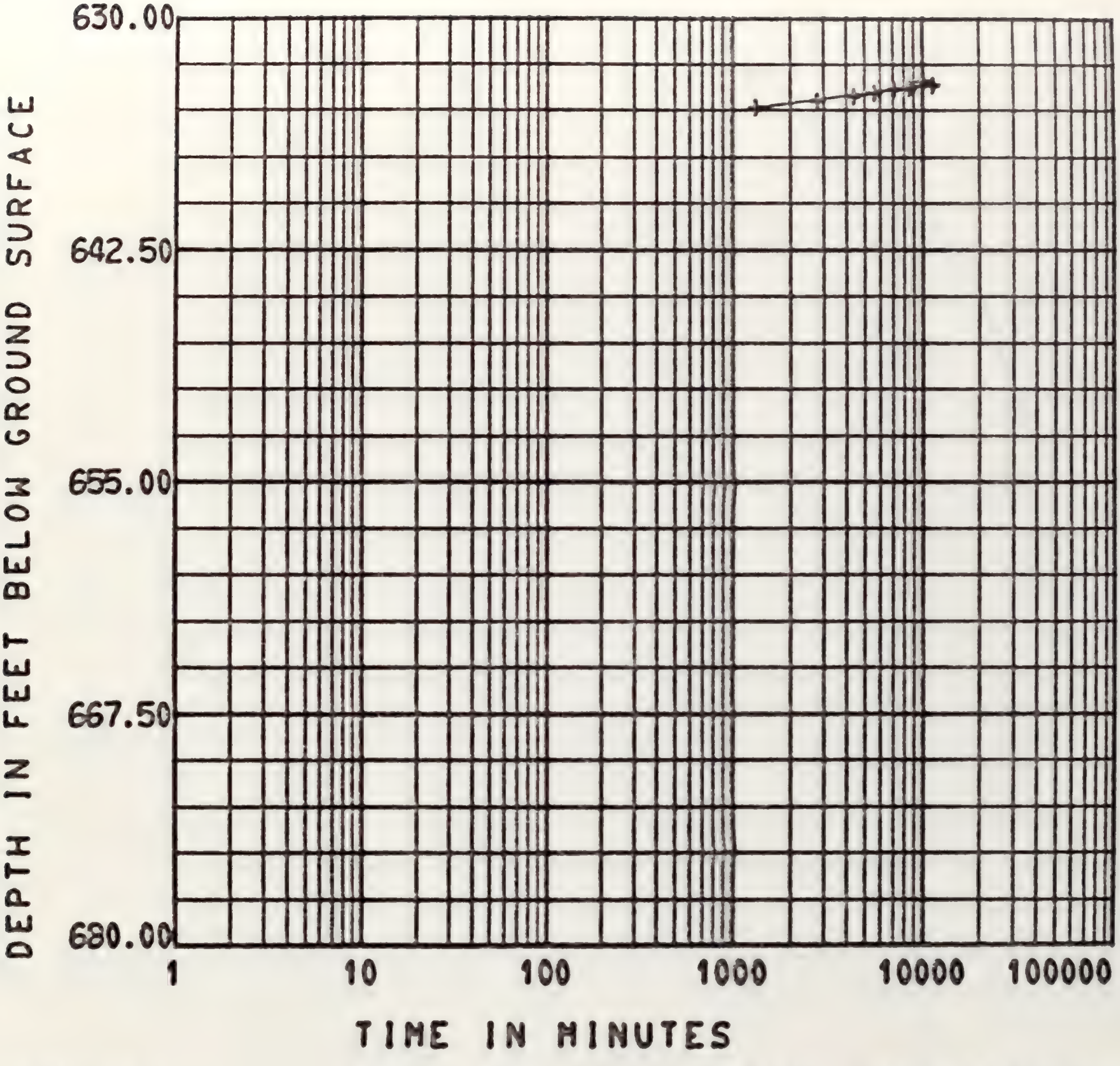
AM-2A GS-16 LOWR DRAWDOWN



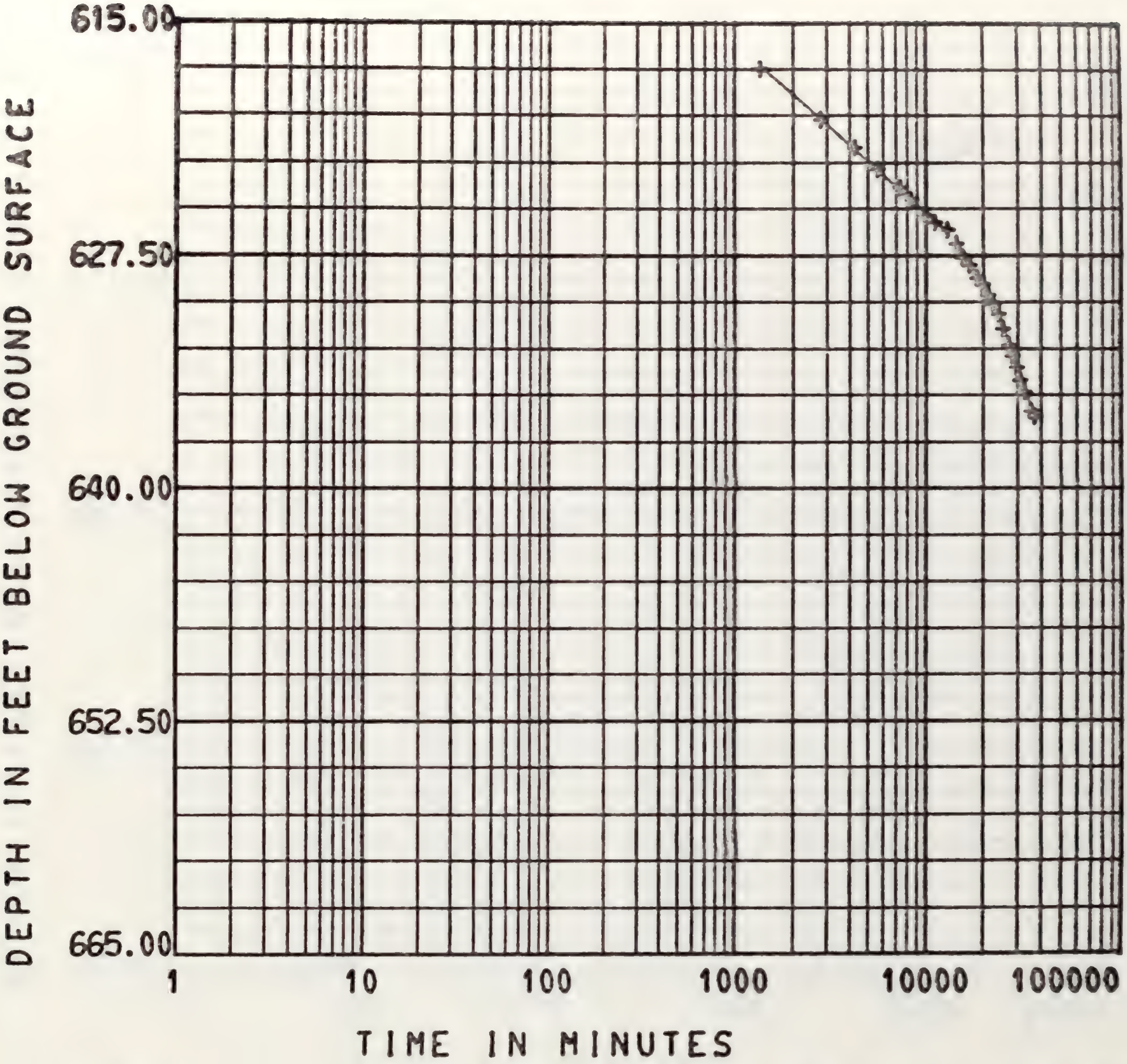
AM-2A GS-17 LOWR DRAWDOWN



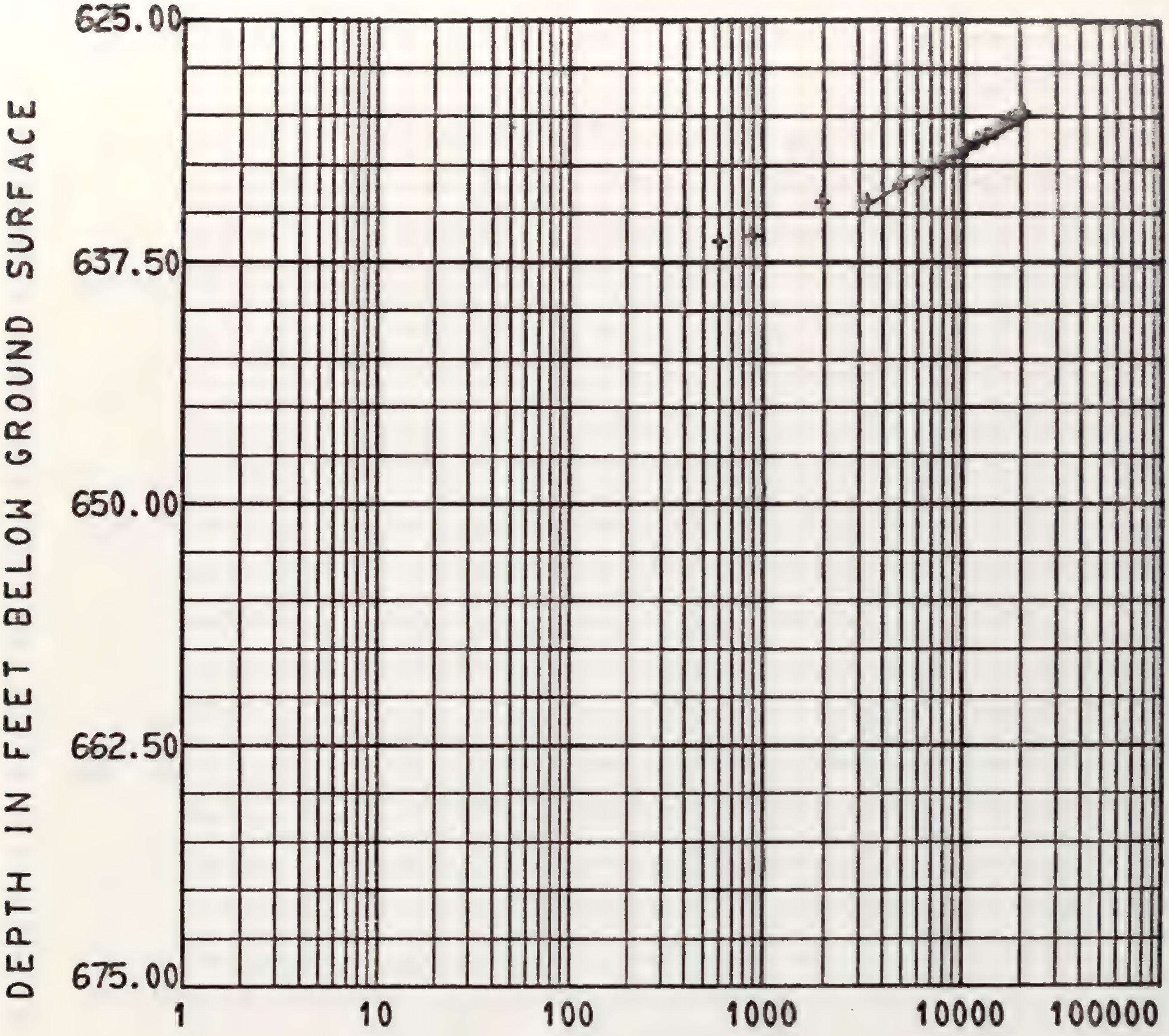
AM-2A GS-17 LOWR RECOVERY



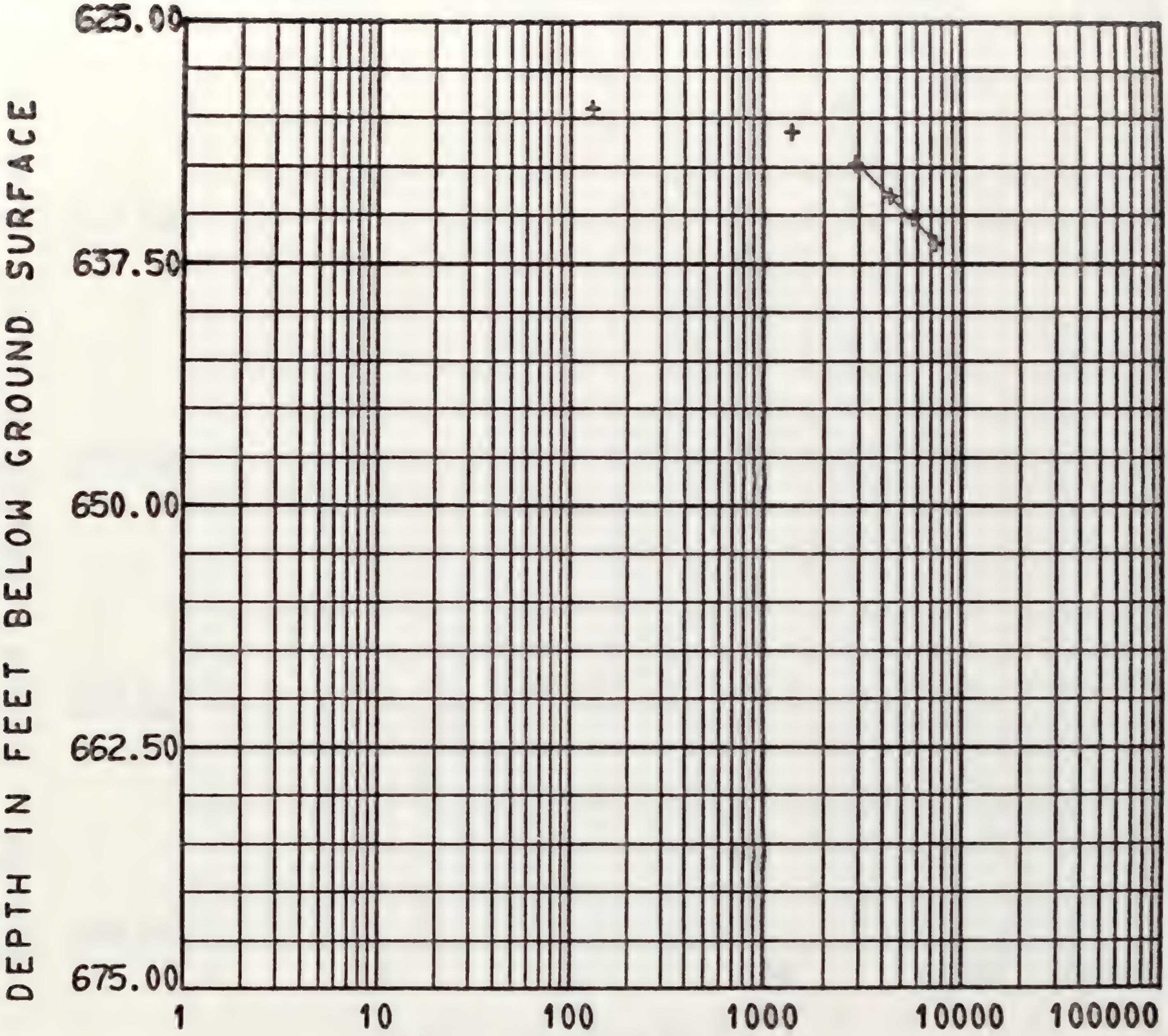
AM-2A GS-18 LOWR RECOVERY



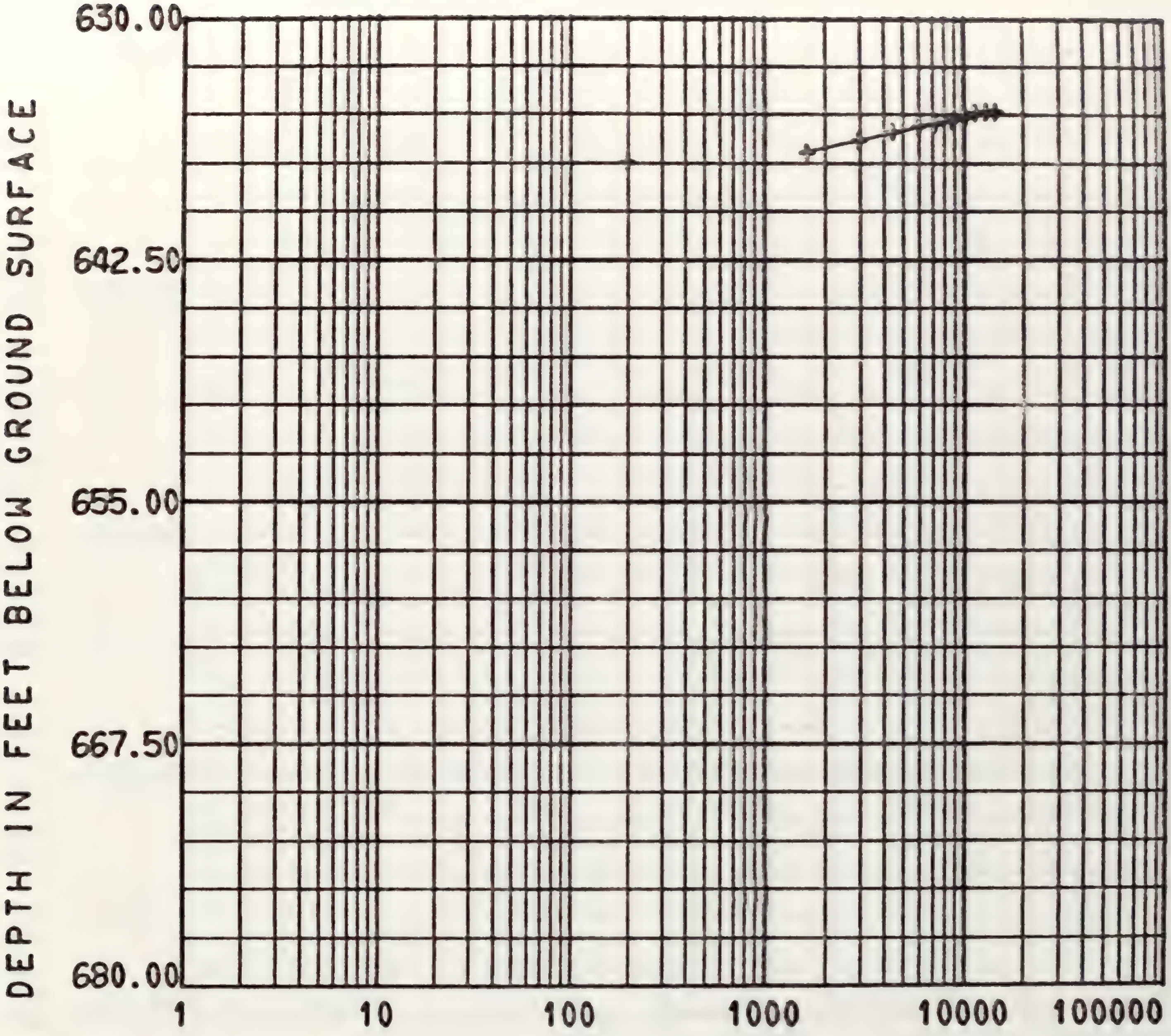
AM-2A GS-19 LOWR DRAWDOWN



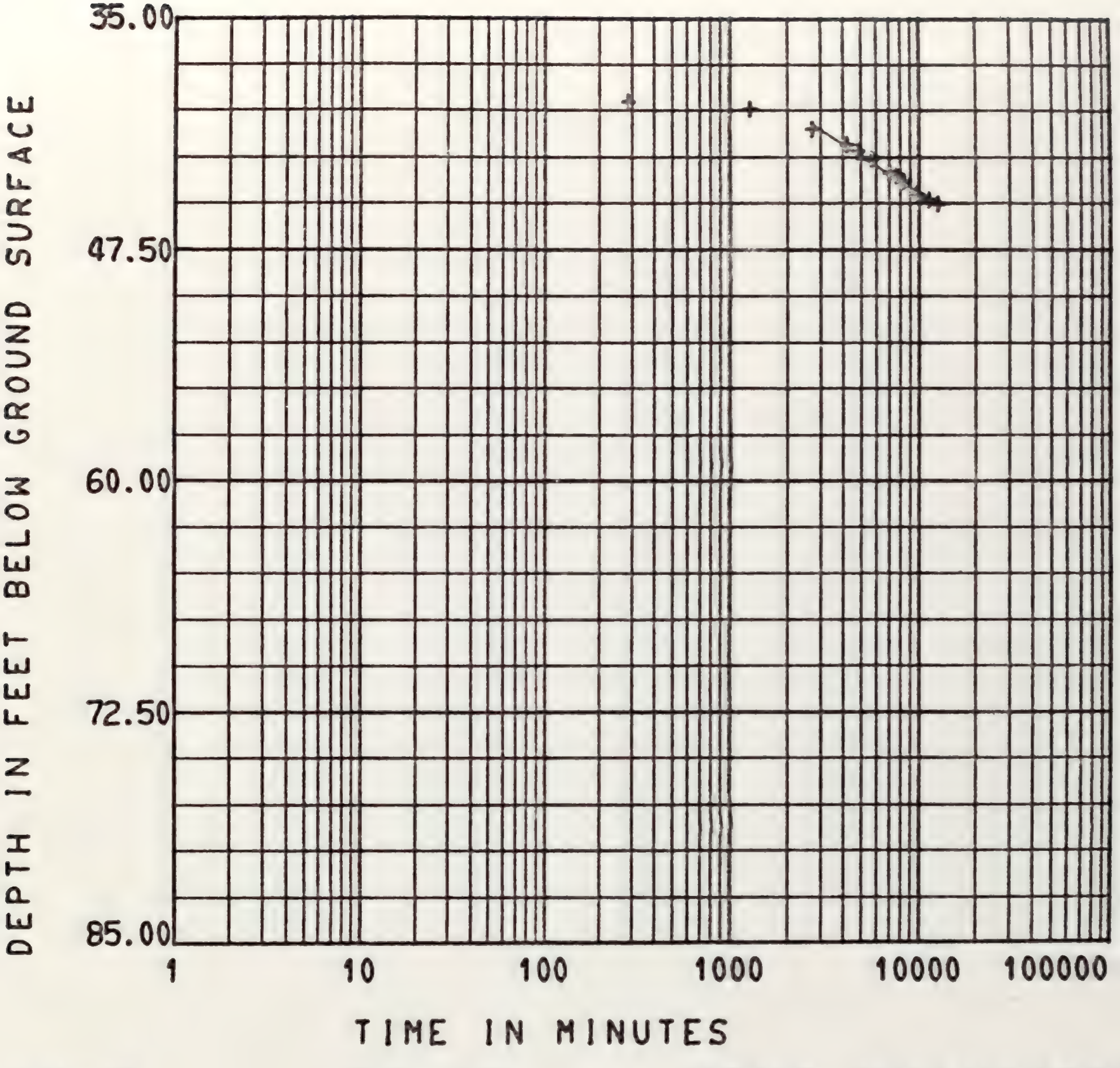
AM-2A GS-19 LOWR RECOVERY



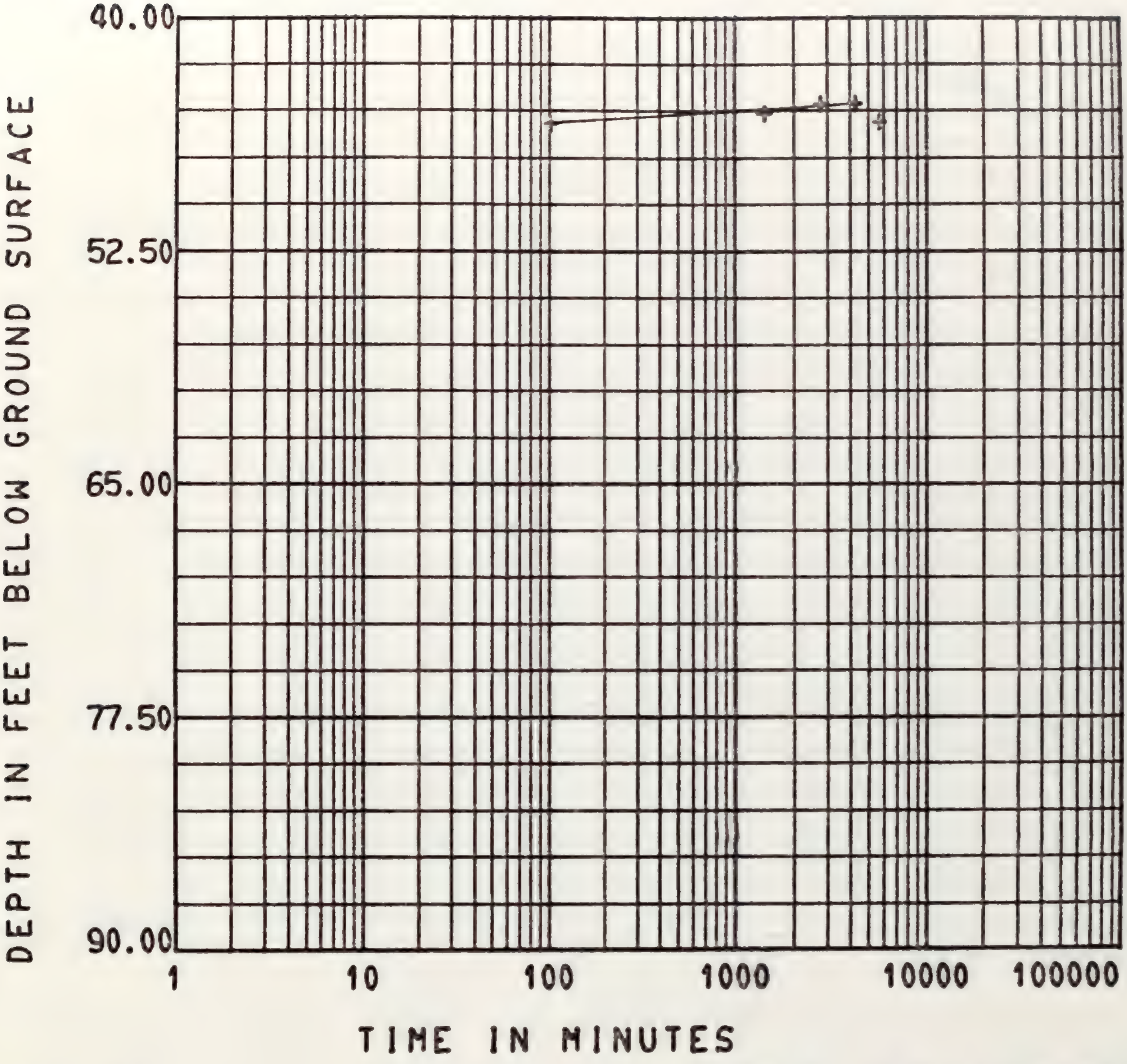
AM-2A GS-19 LOWR DRAWDOWN



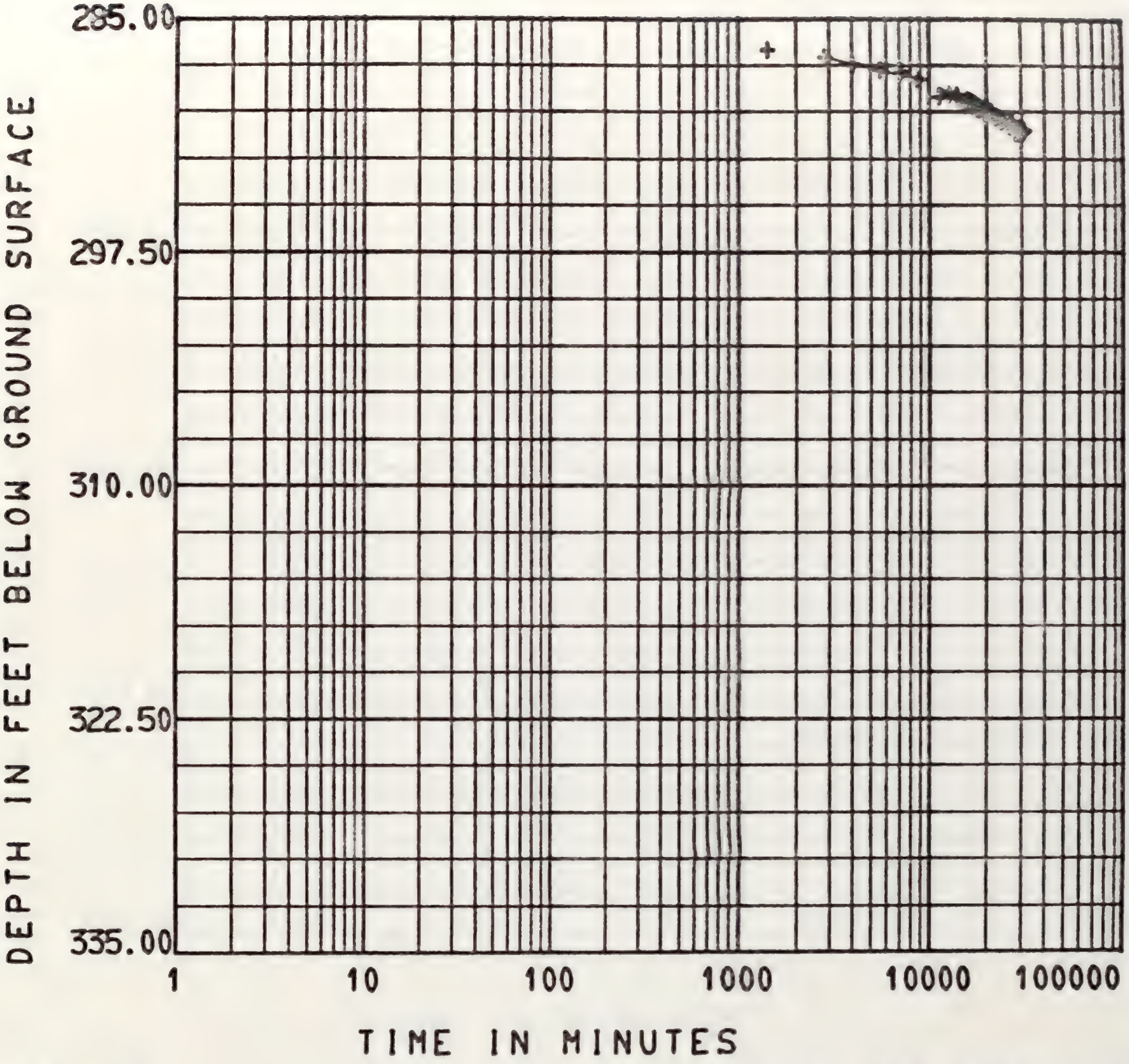
AM-2A GS-19 LOWR RECOVERY



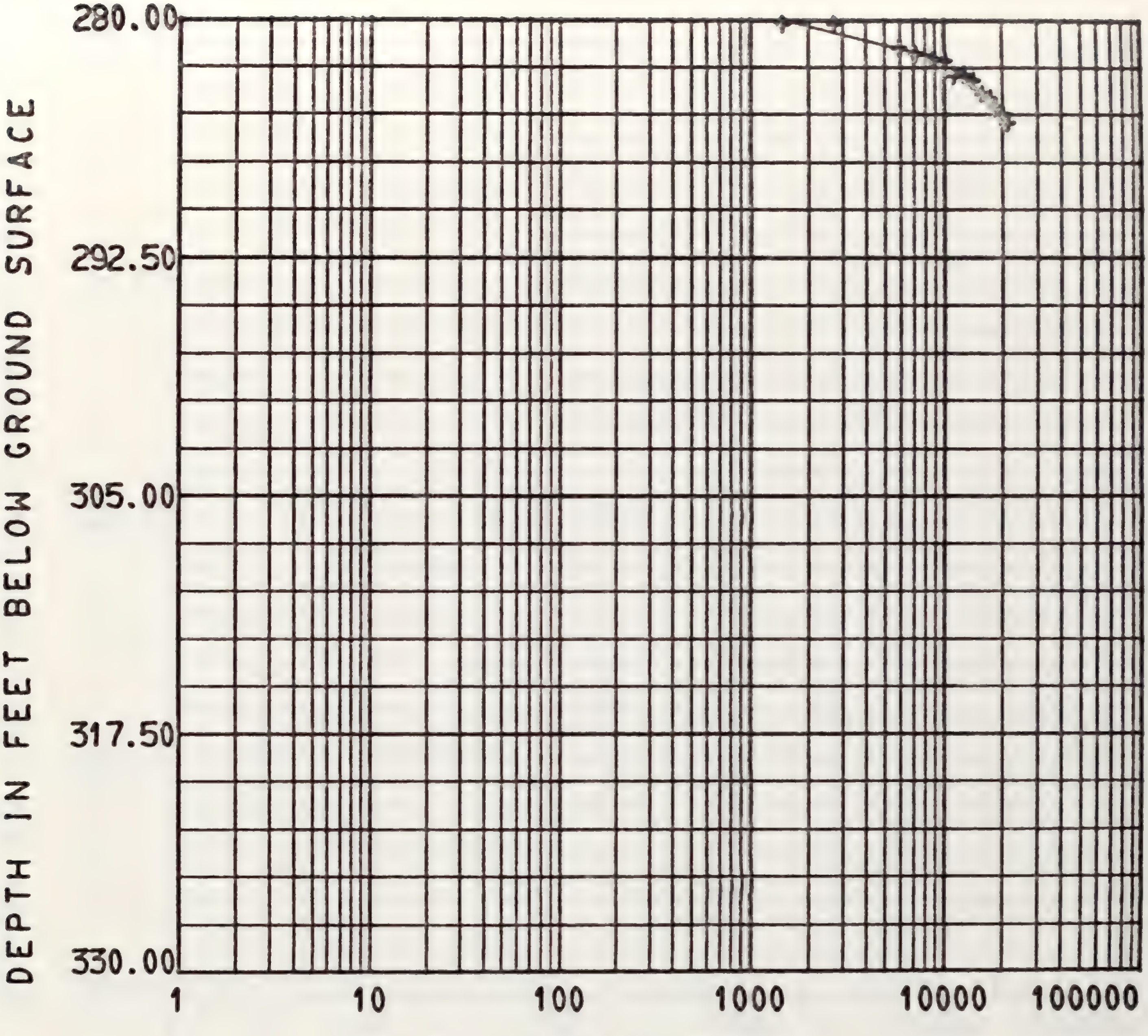
AM-3 GS-12 UPPR DRAWDOWN



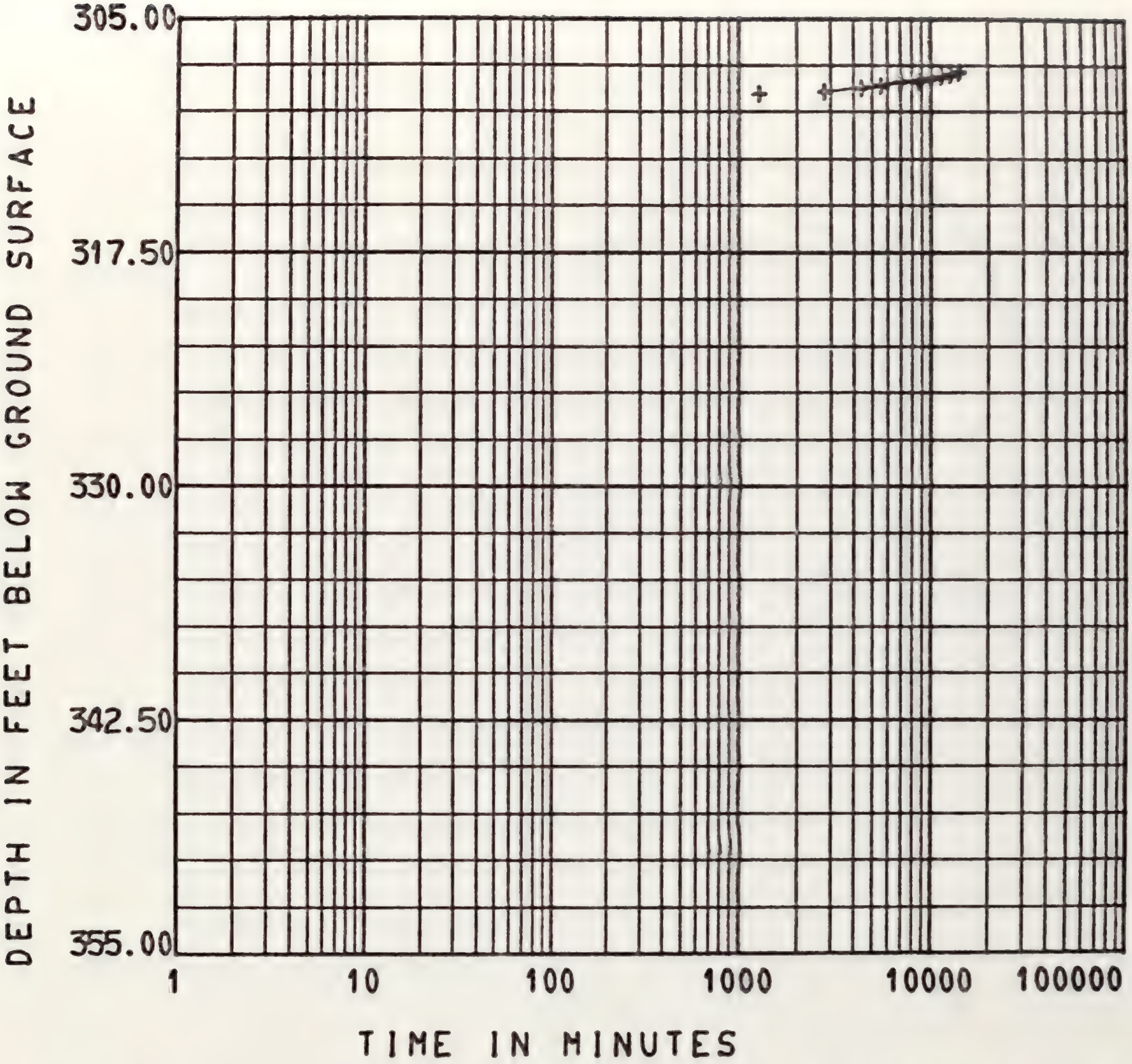
AM-3 GS-12 UPPR RECOVERY



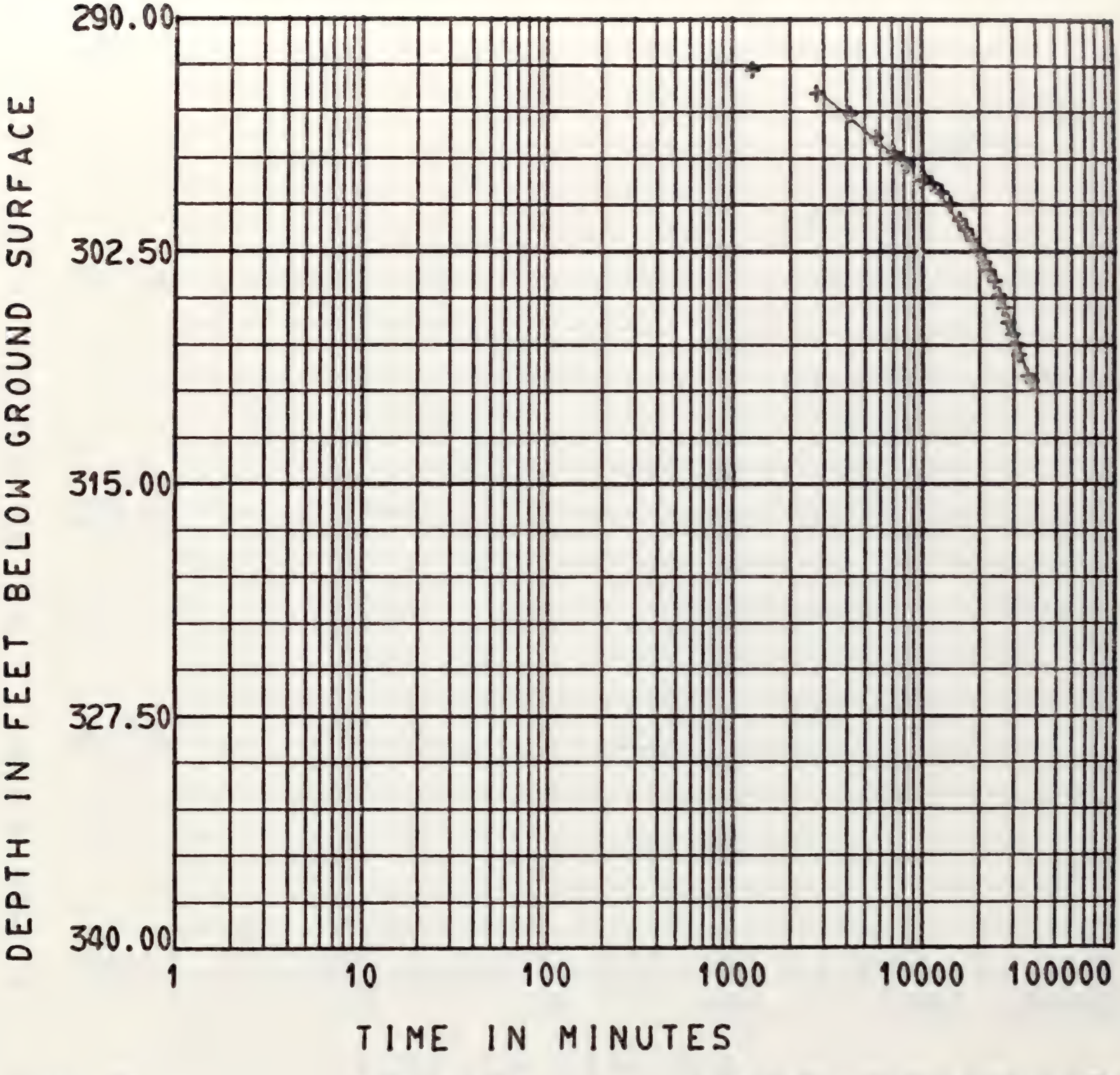
AM-3 GS-16 LOWR DRAWDOWN



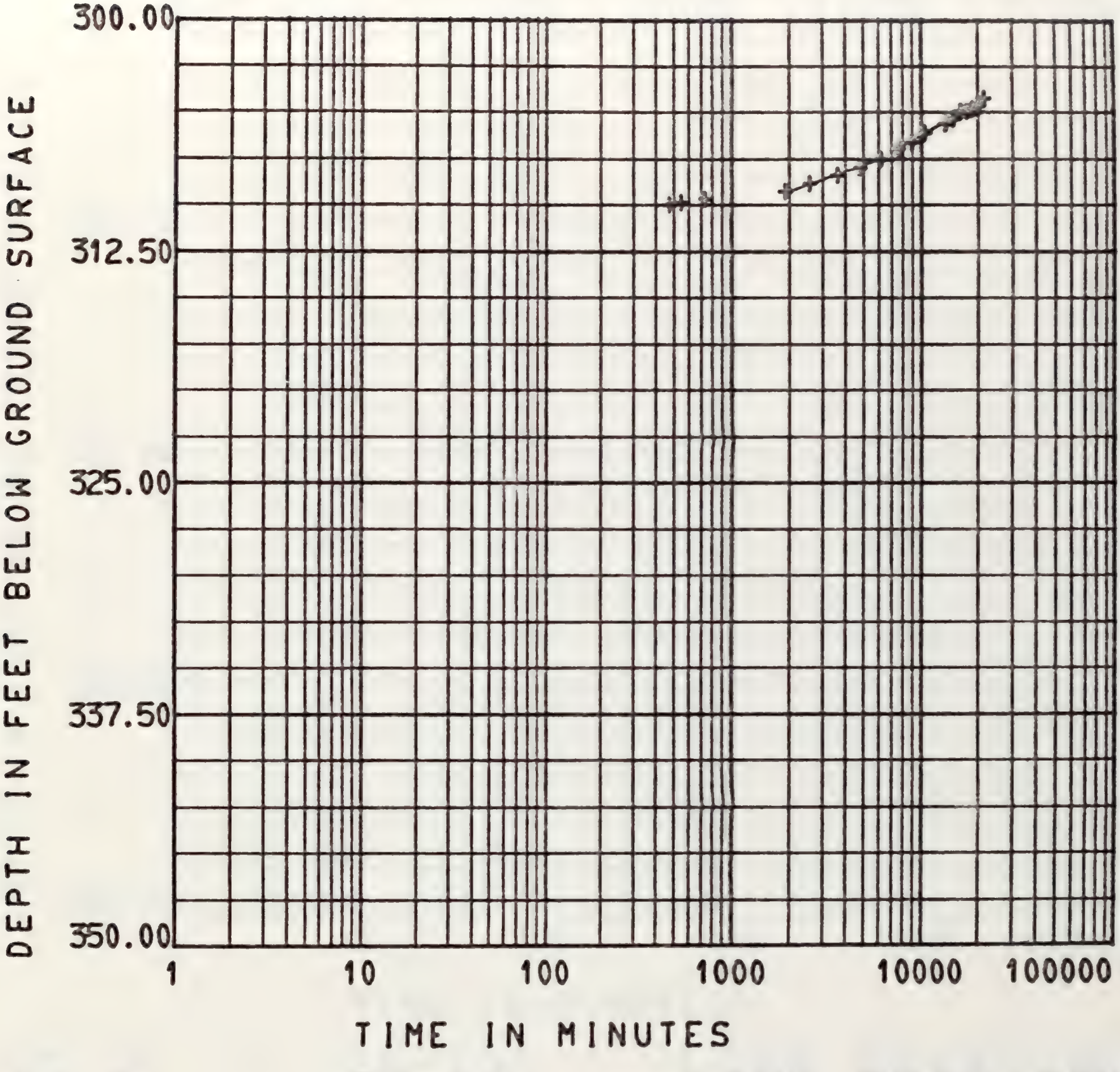
AM-3 GS-17 LOWR DRAWDOWN



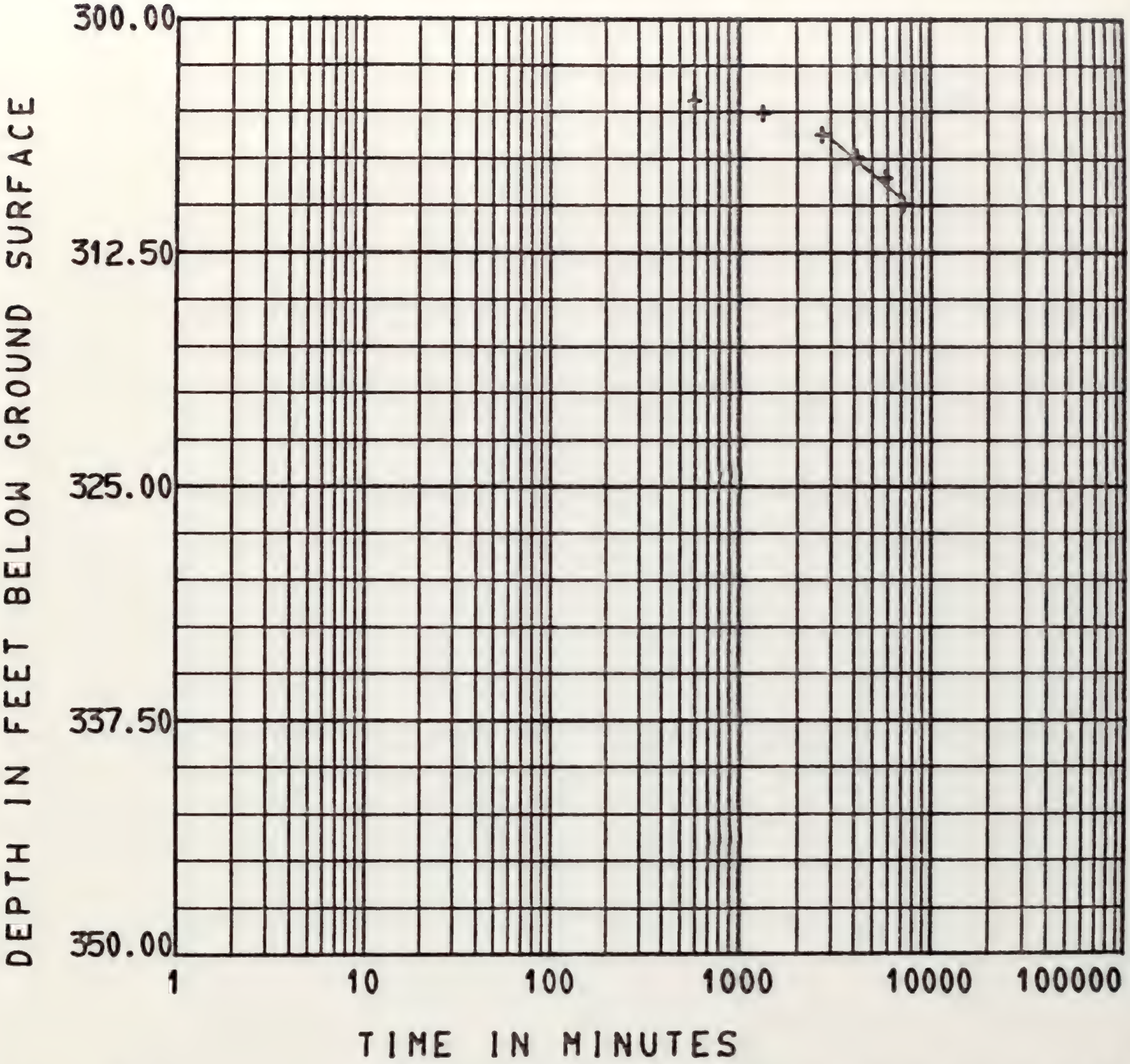
AM-3 GS-18 LOWR RECOVERY



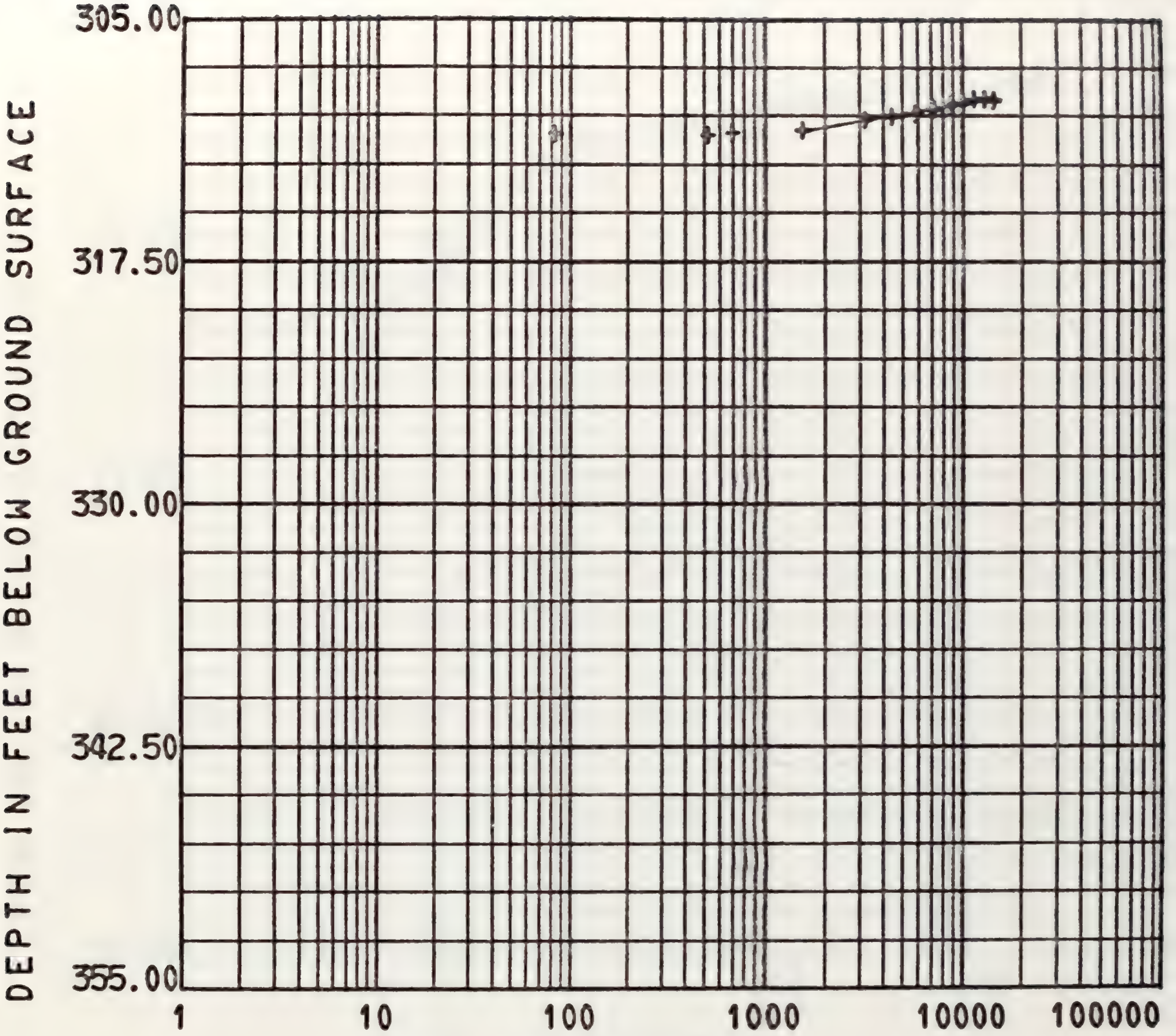
AM-3 GS-19 LOWR DRAWDOWN



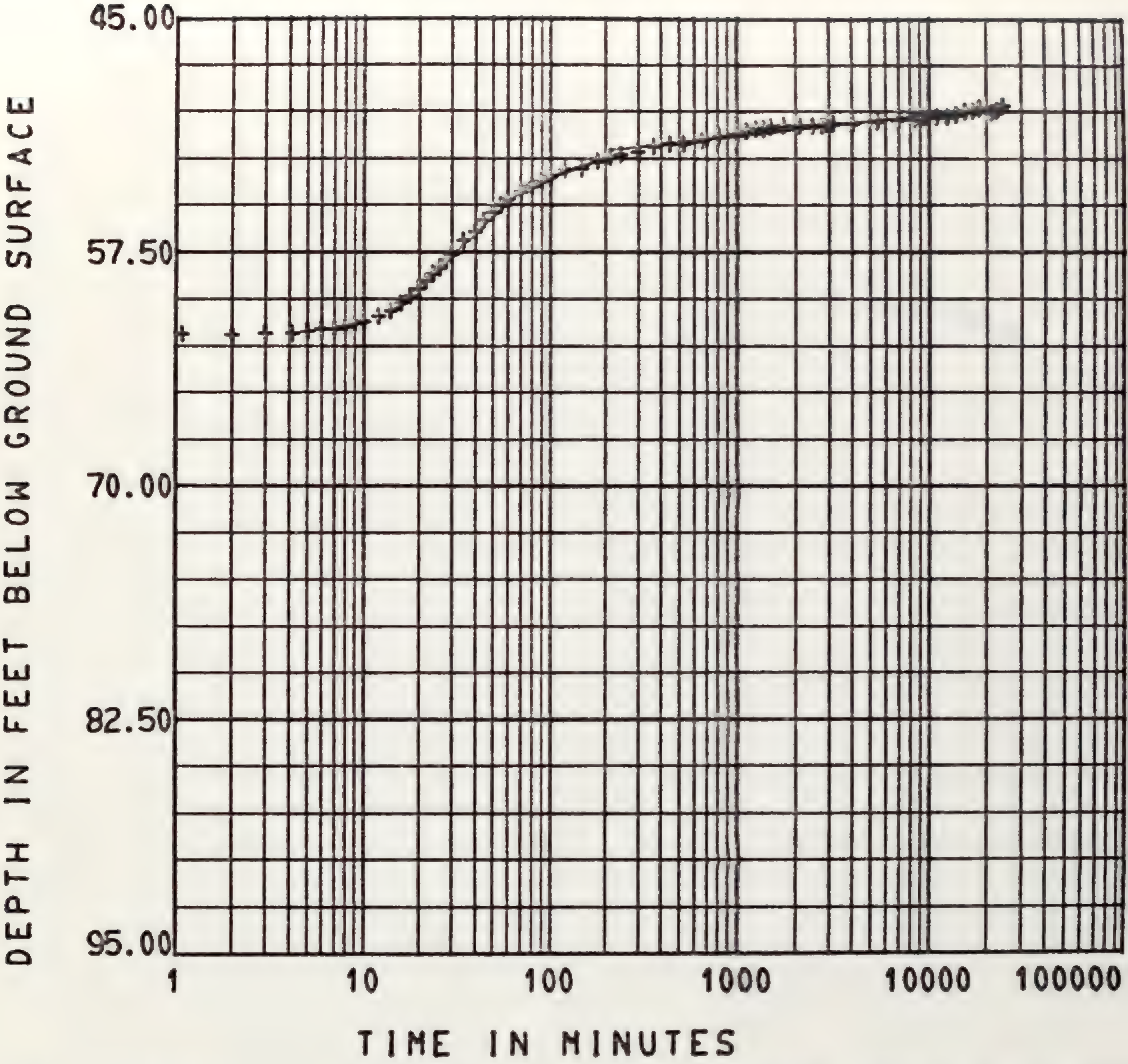
AM-3 GS-19 LOWR RECOVERY



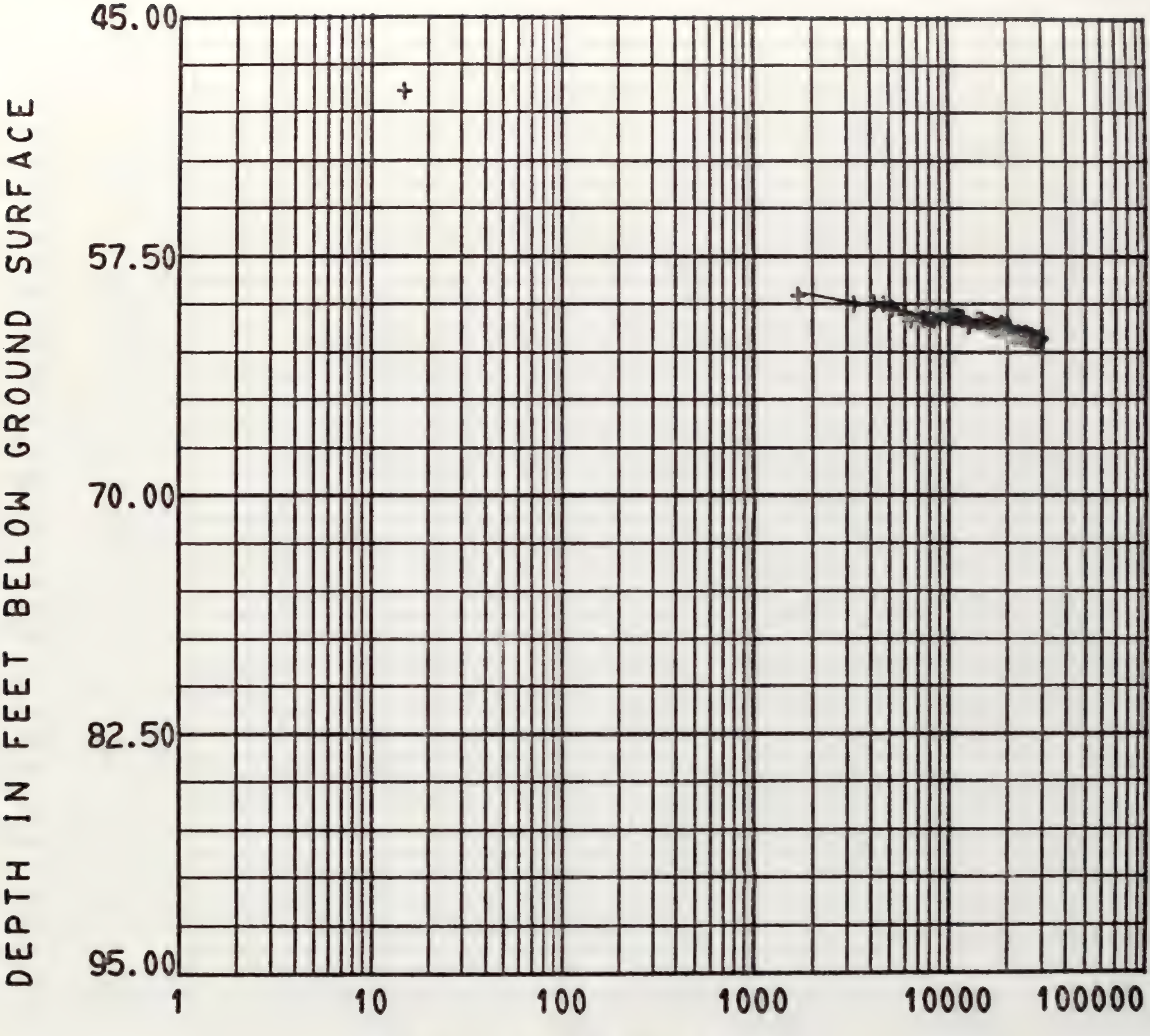
AM-3 GS-19 LOWR DRAWDOWN



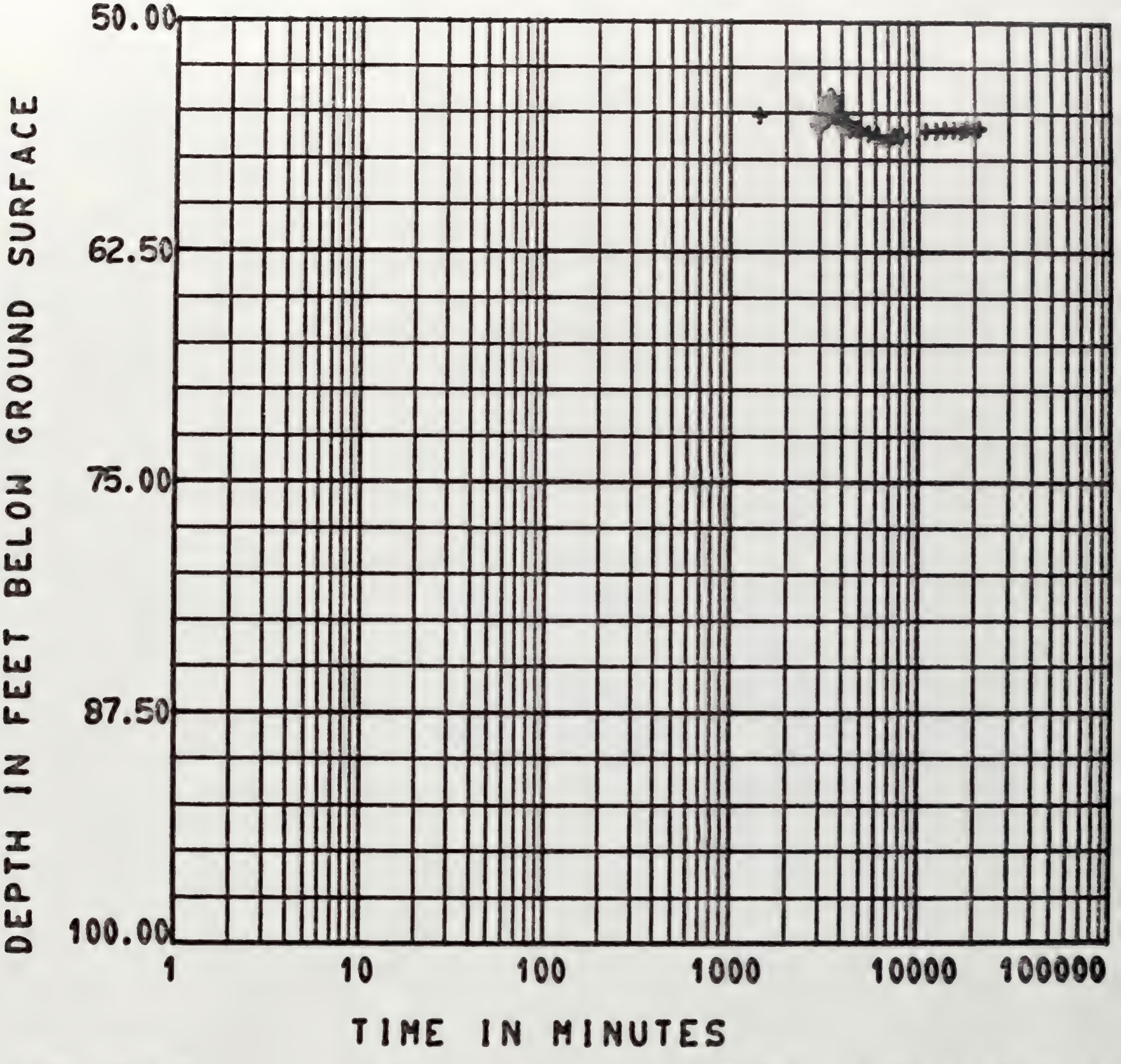
AM-3 GS-19 LOWR RECOVERY



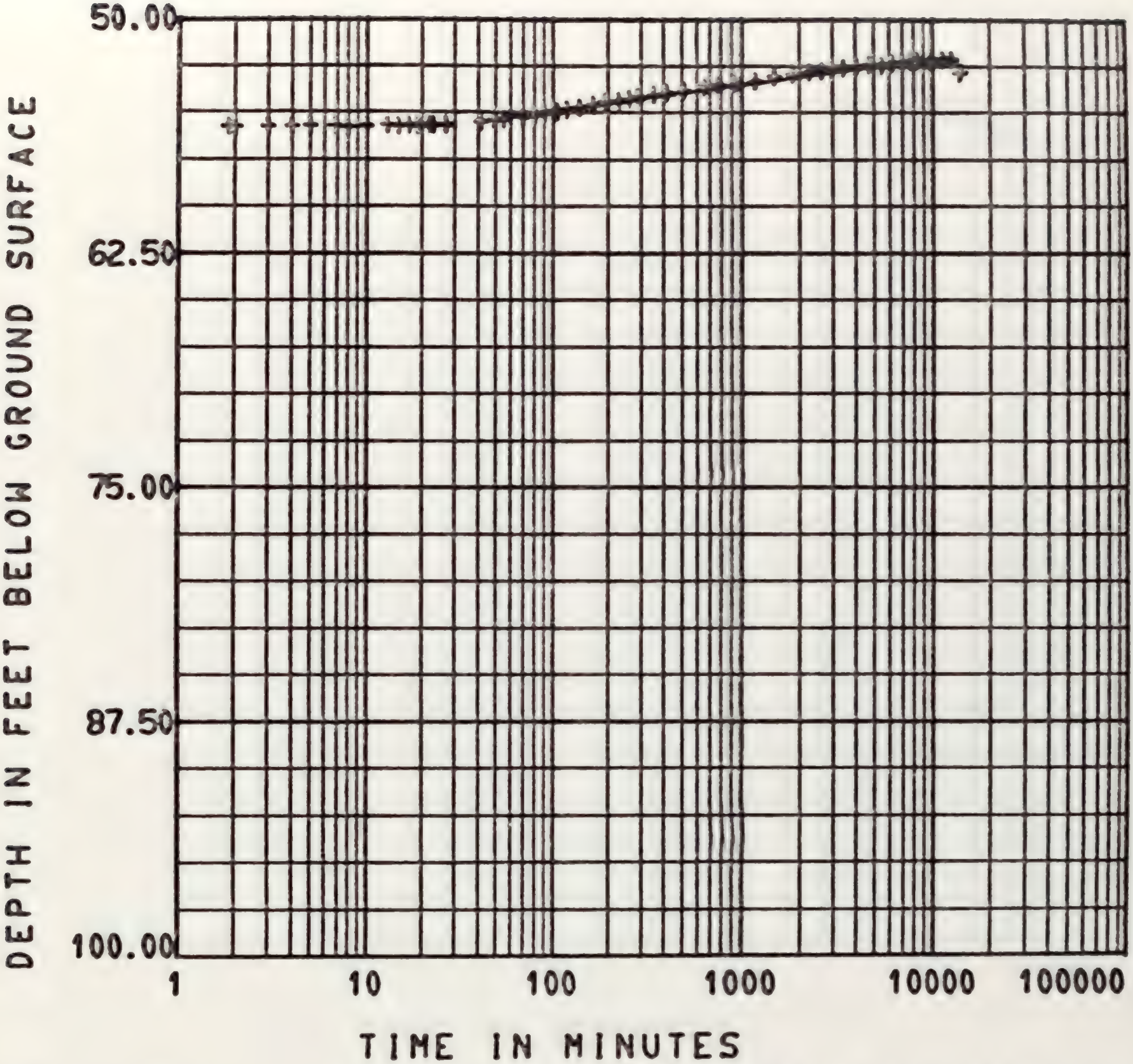
CE 702 TO-3 UPPR RECOVERY



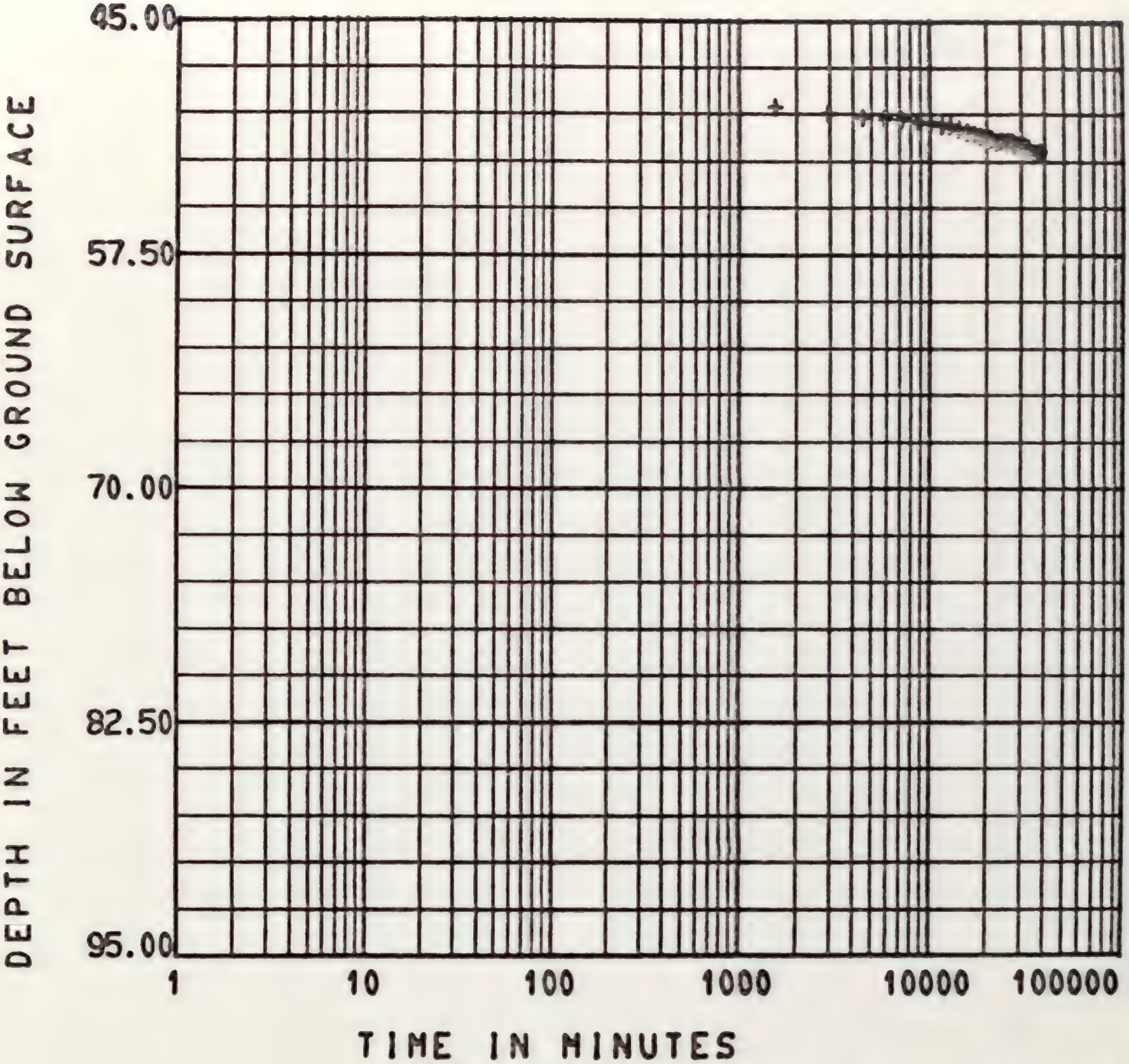
CE 702 TO-3 UPPR DRAWDOWN



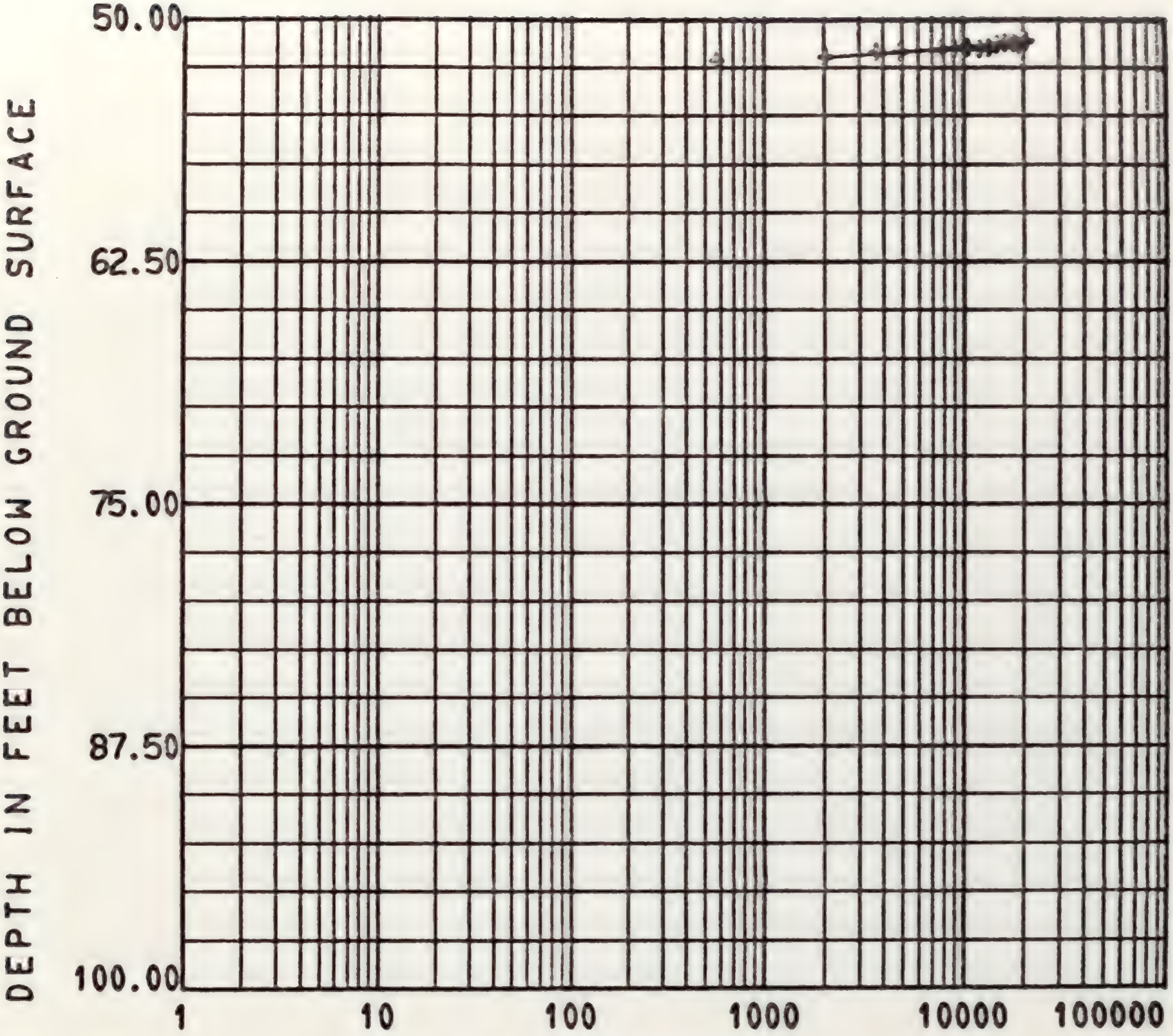
CE 702 GS-18 UPPR DRAWDOWN



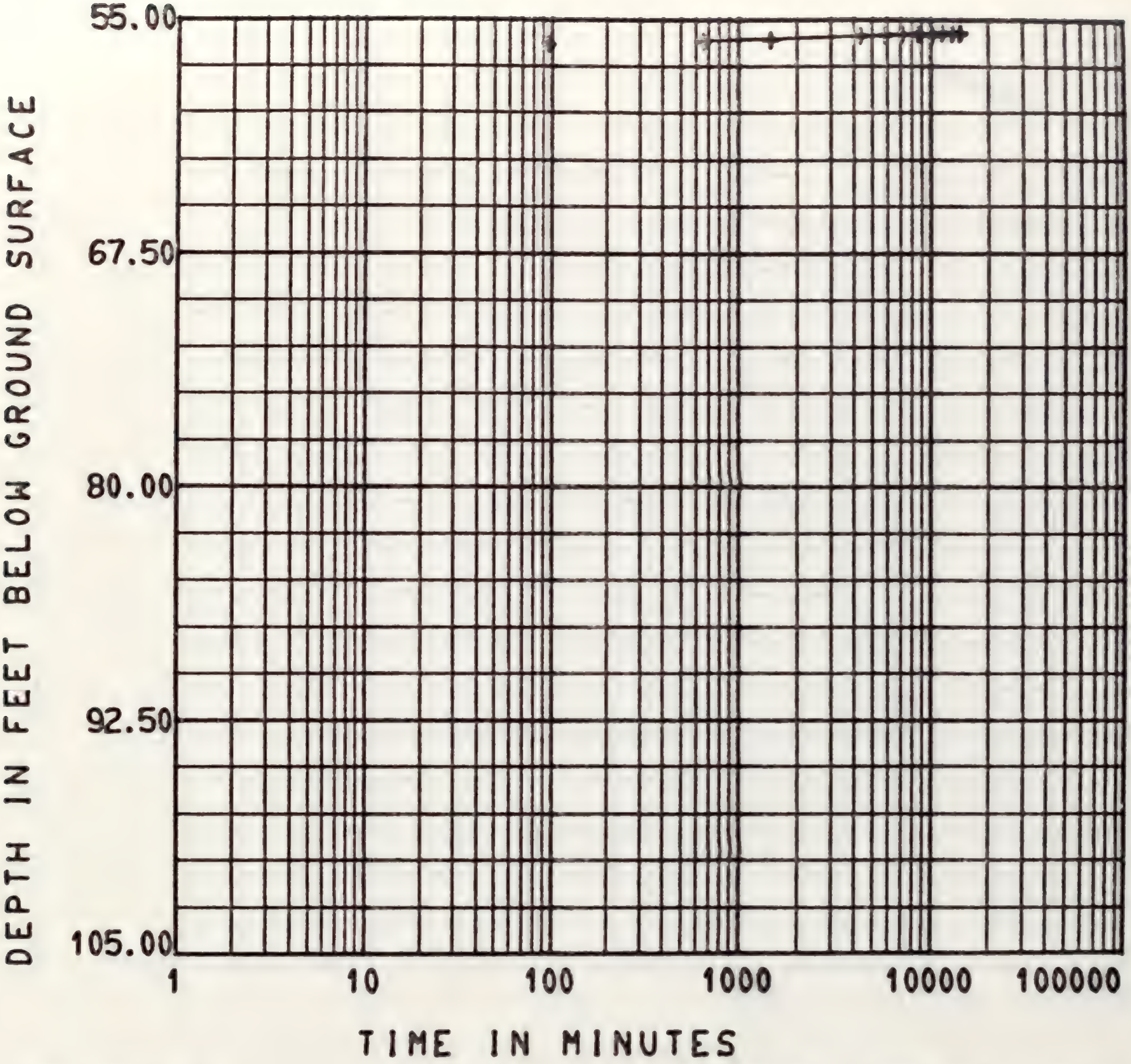
CE 702 GS-18 UPPR RECOVERY



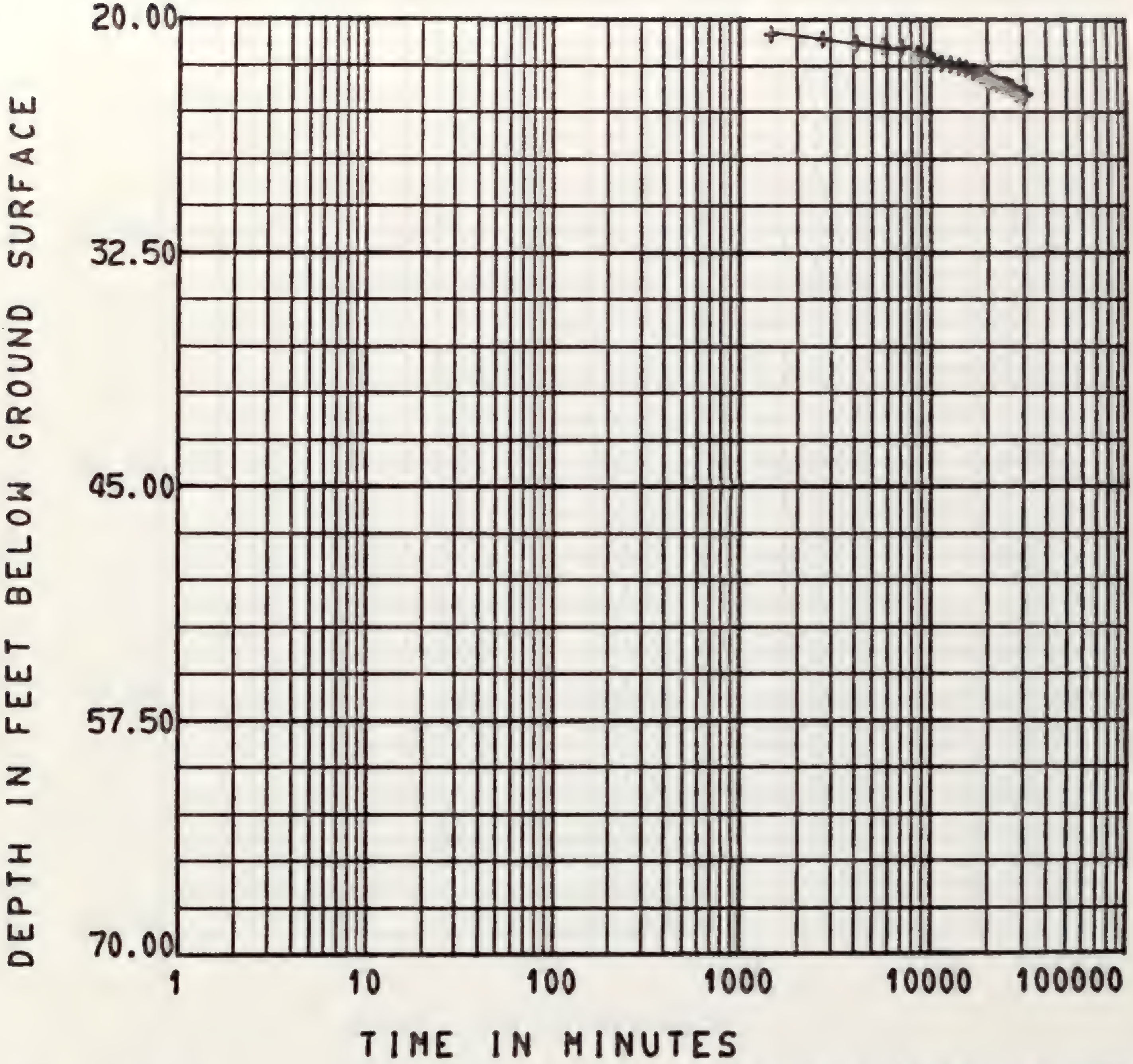
CE 702 GS-19 UPPR DRAWDOWN



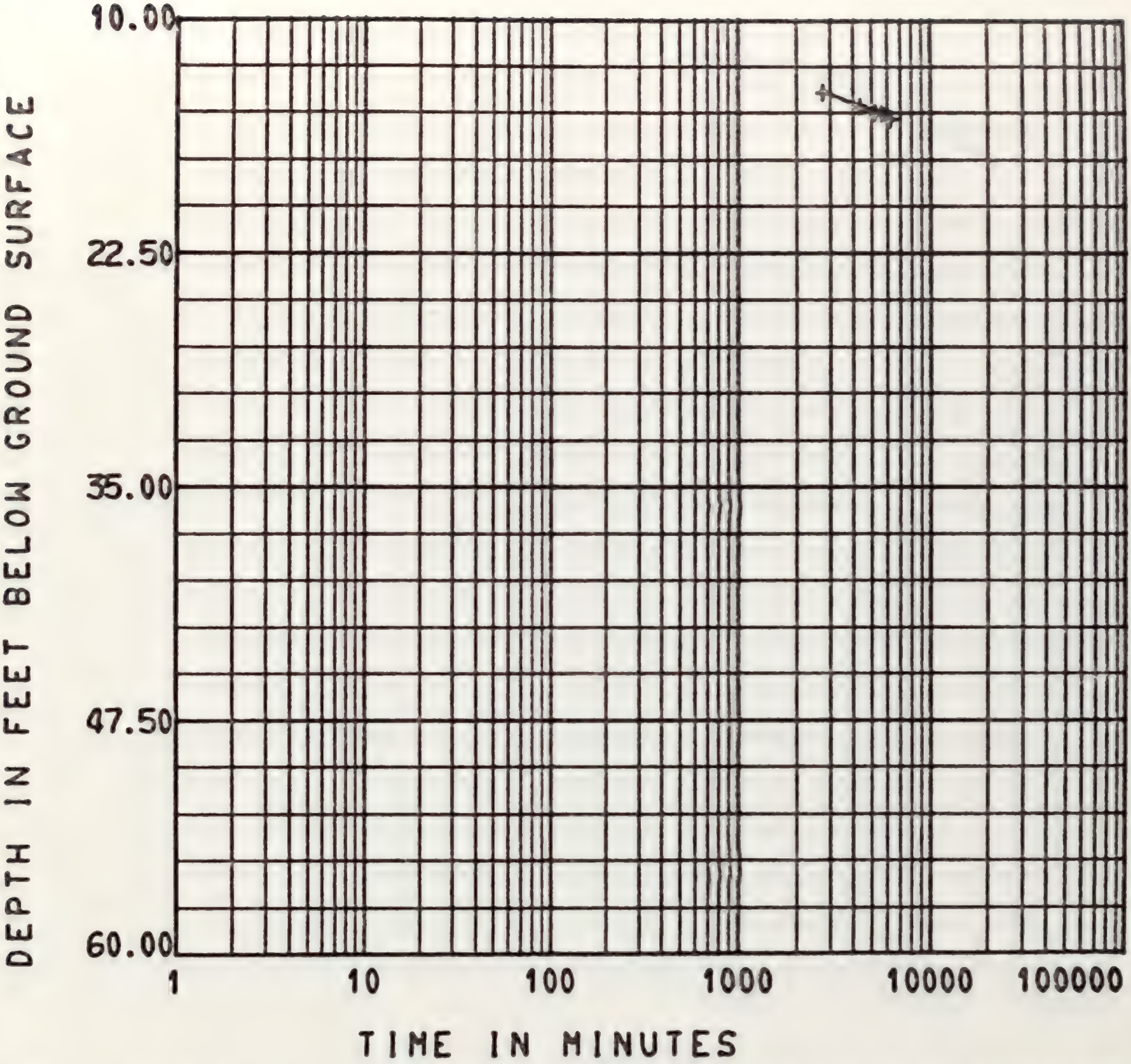
CE 702 GS-19 UPPR RECOVERY



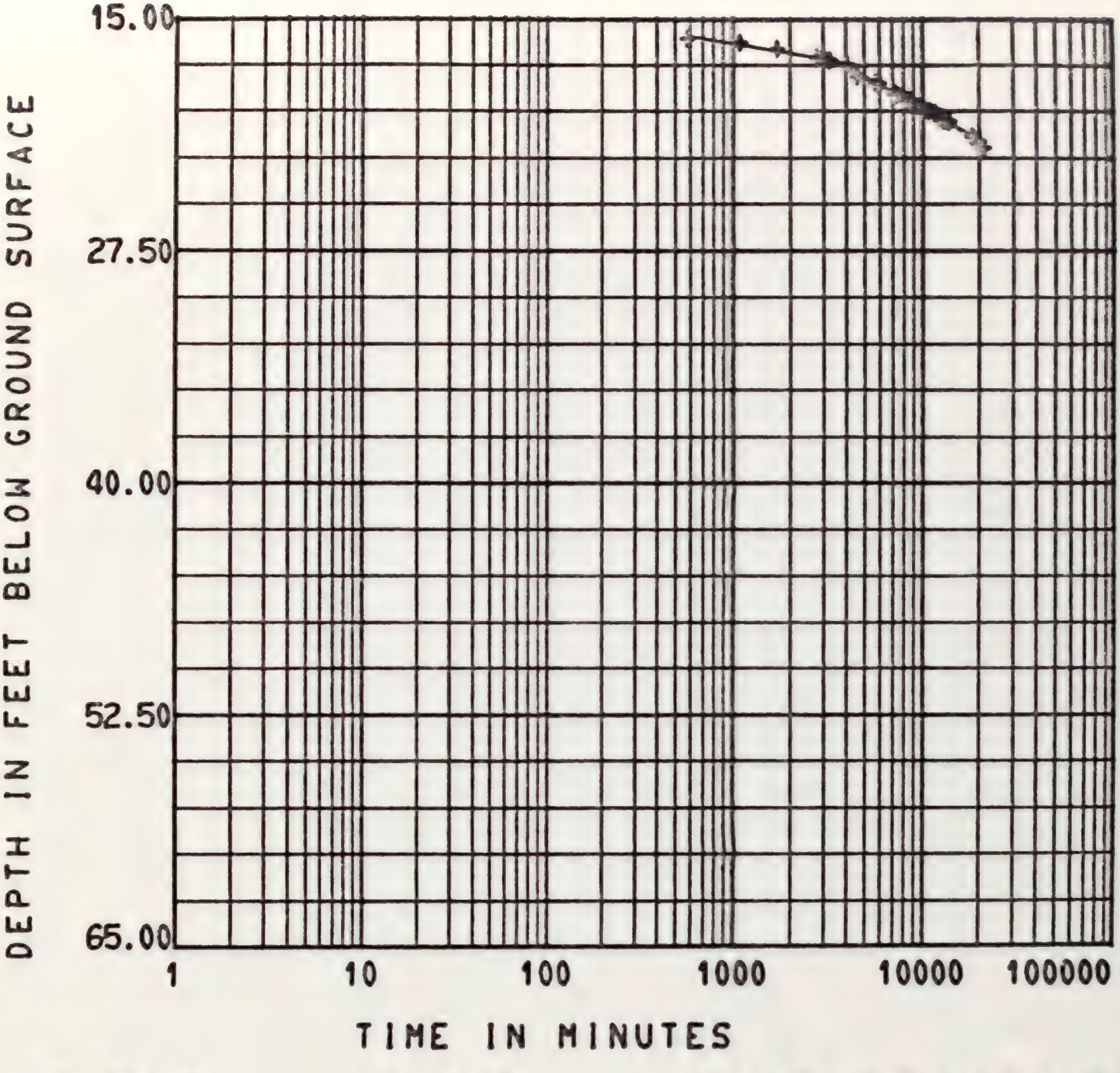
CE 702 GS-19 UPPR RECOVERY



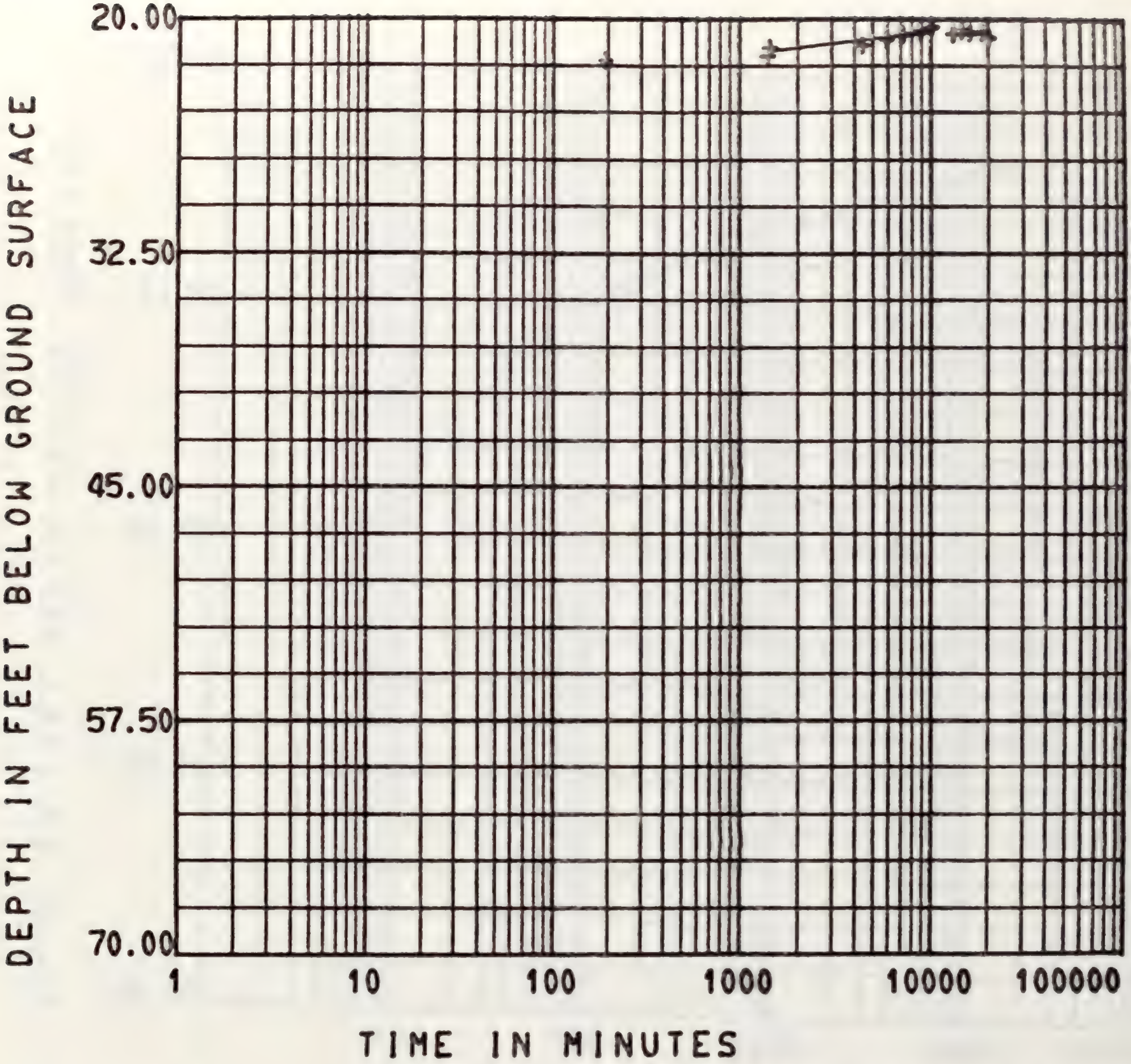
CE 702 GS-16 LOWR DRAWDOWN



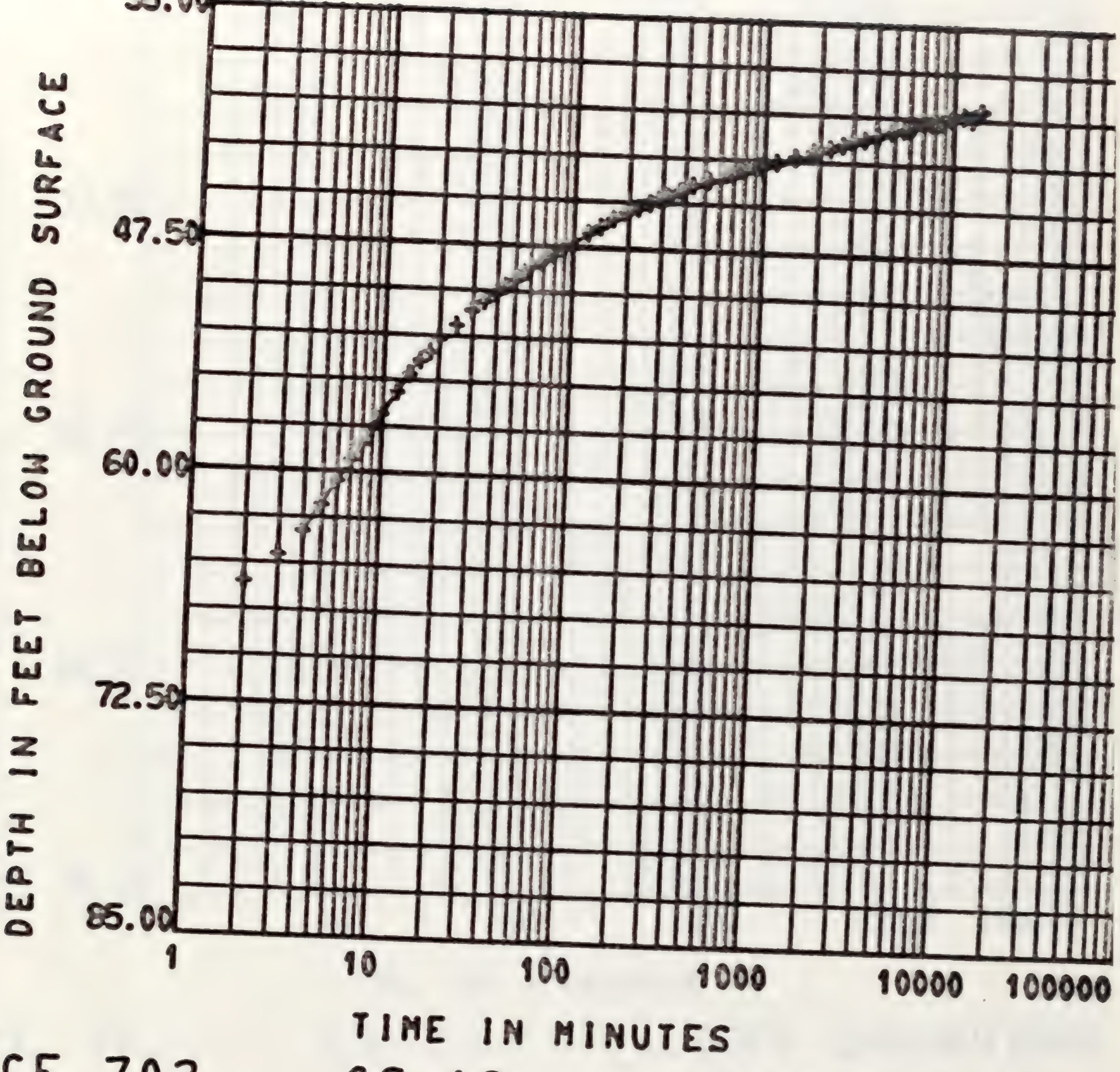
CE 702 GS-17 LOWR DRAWDOWN



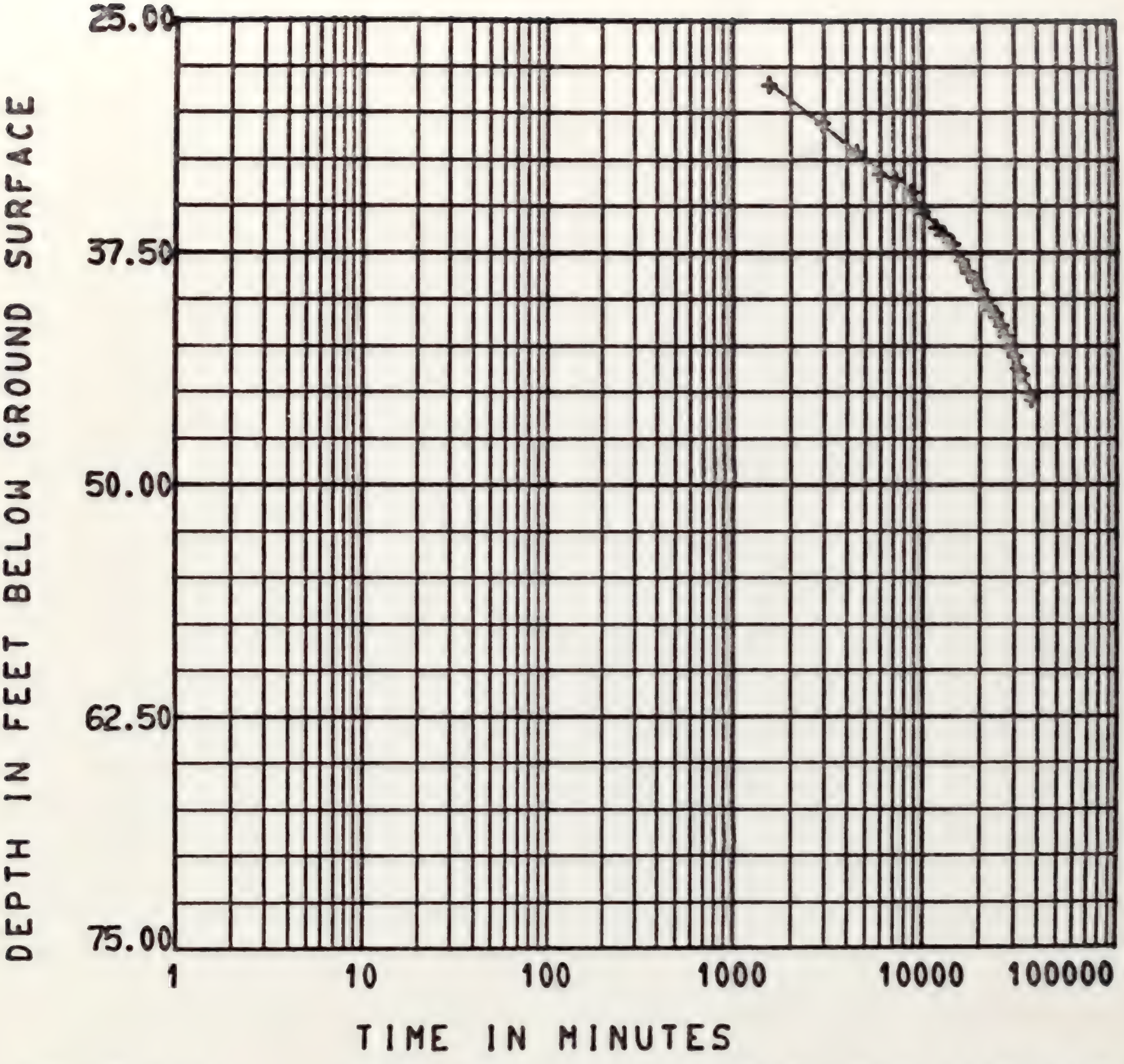
CE 702 GS-17 LOWR DRAWDOWN



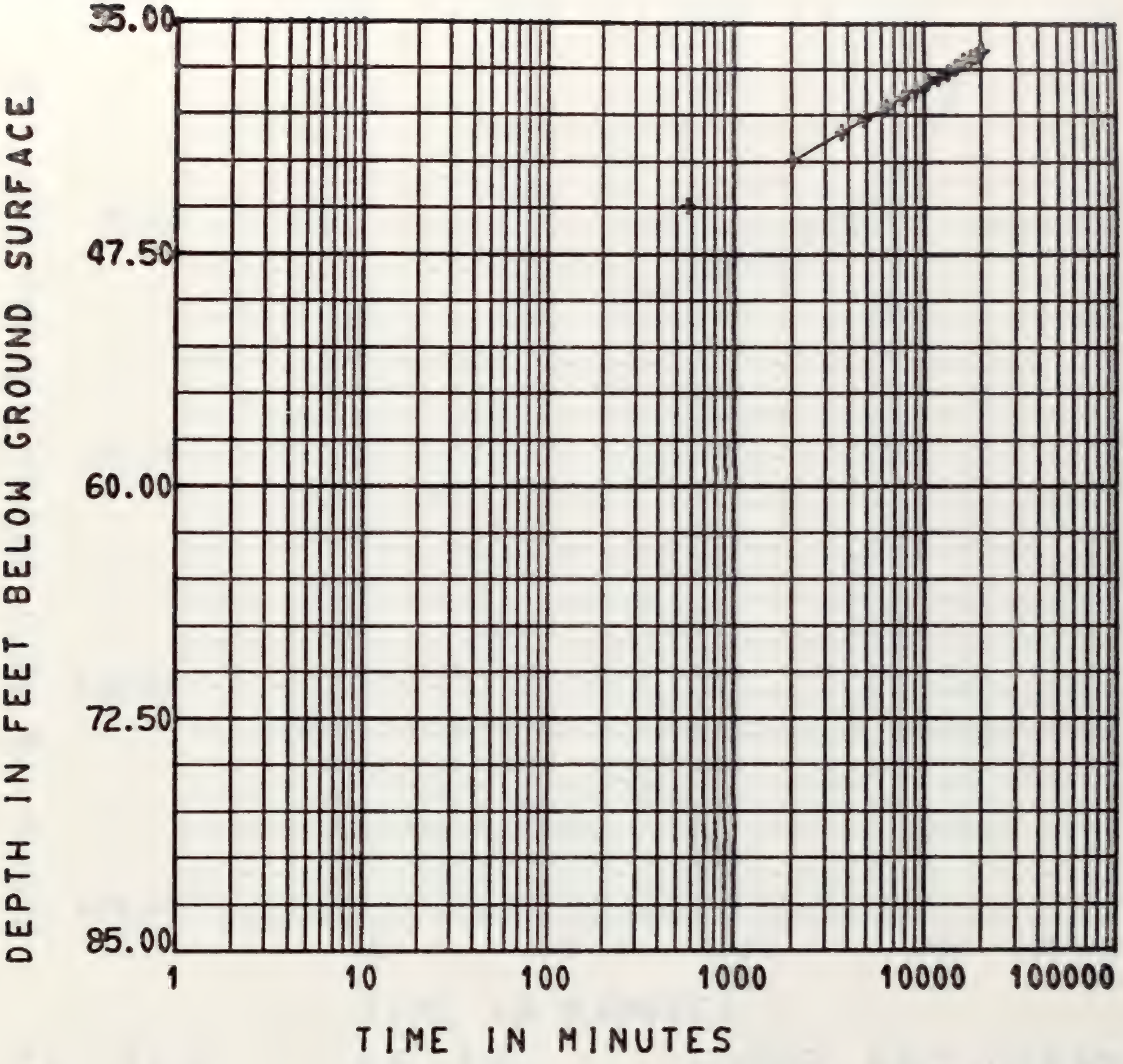
CE 702 GS-17 LOWR RECOVERY



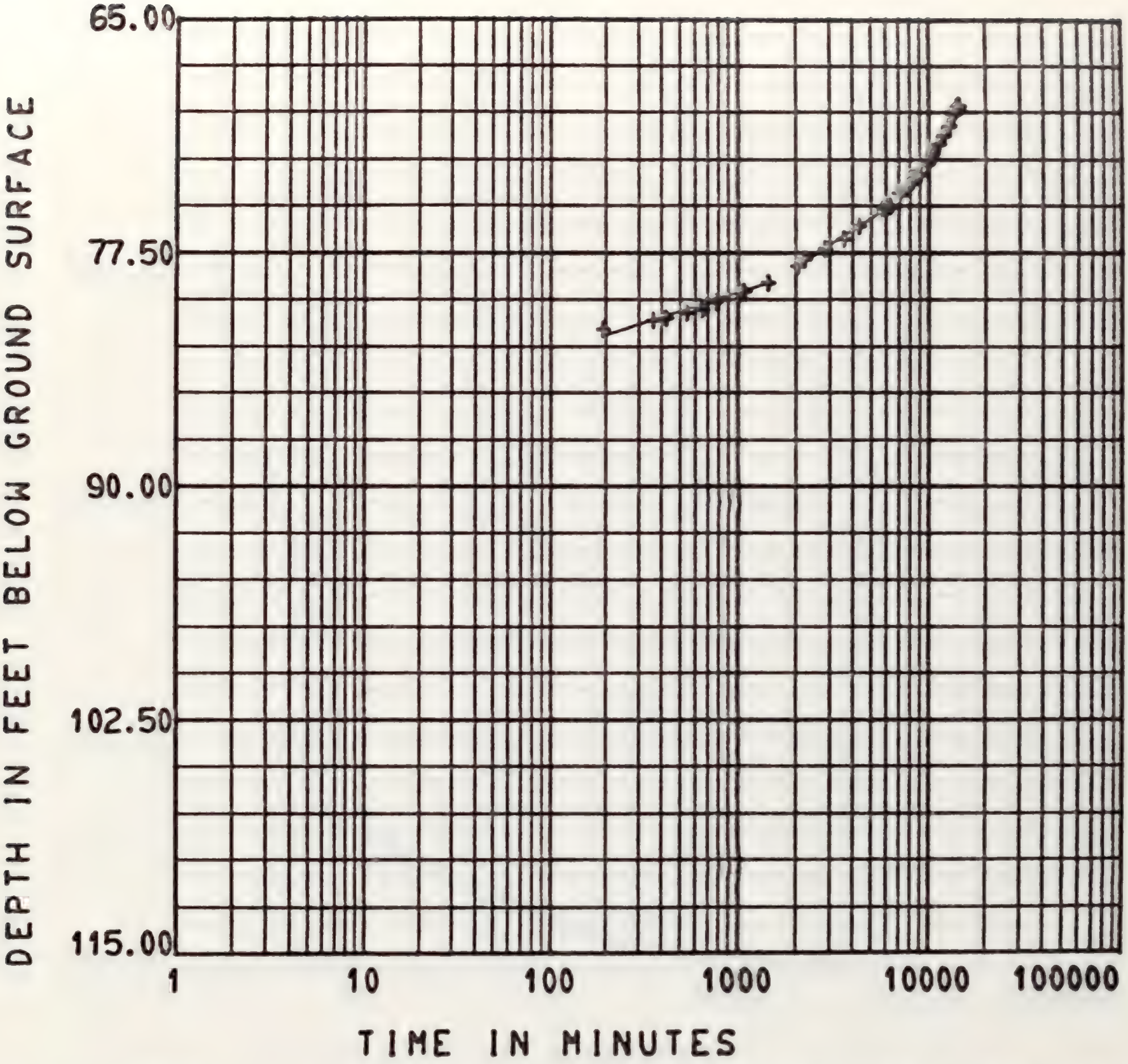
CE 702 GS-18 LOWR RECOVERY



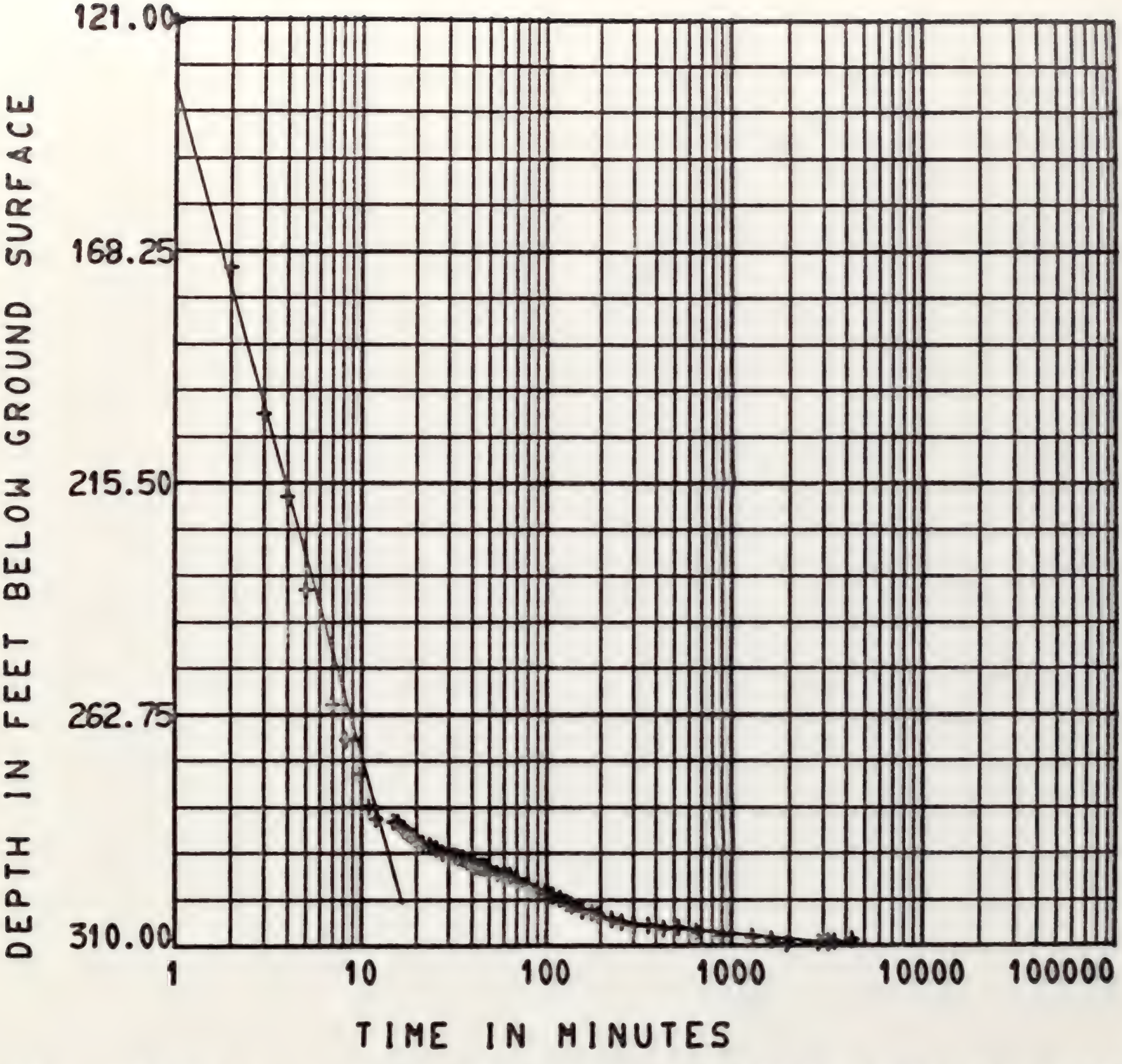
CE 702 GS-19 LOWR DRAWDOWN



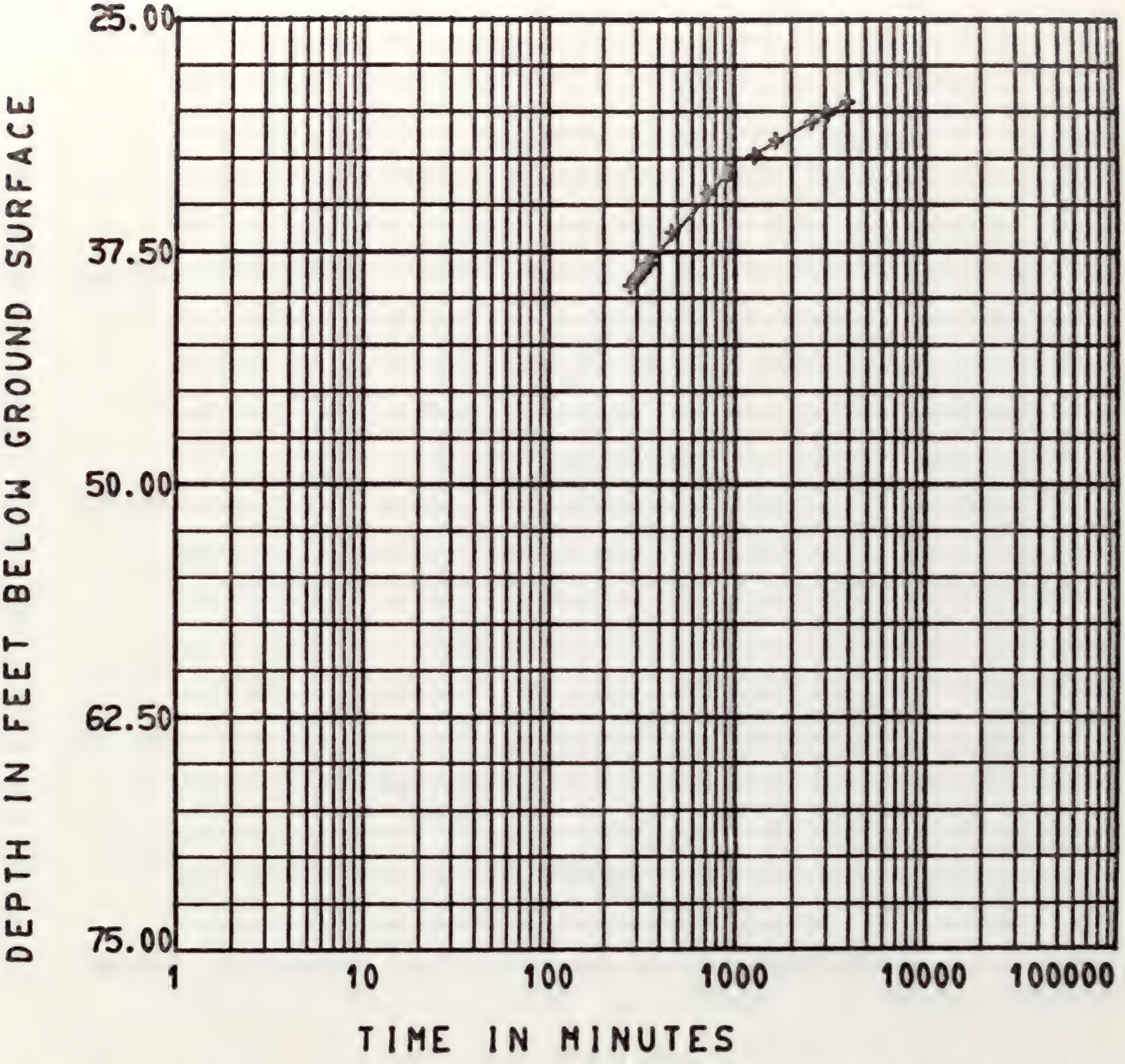
CE 702 GS-19 LOWR RECOVERY



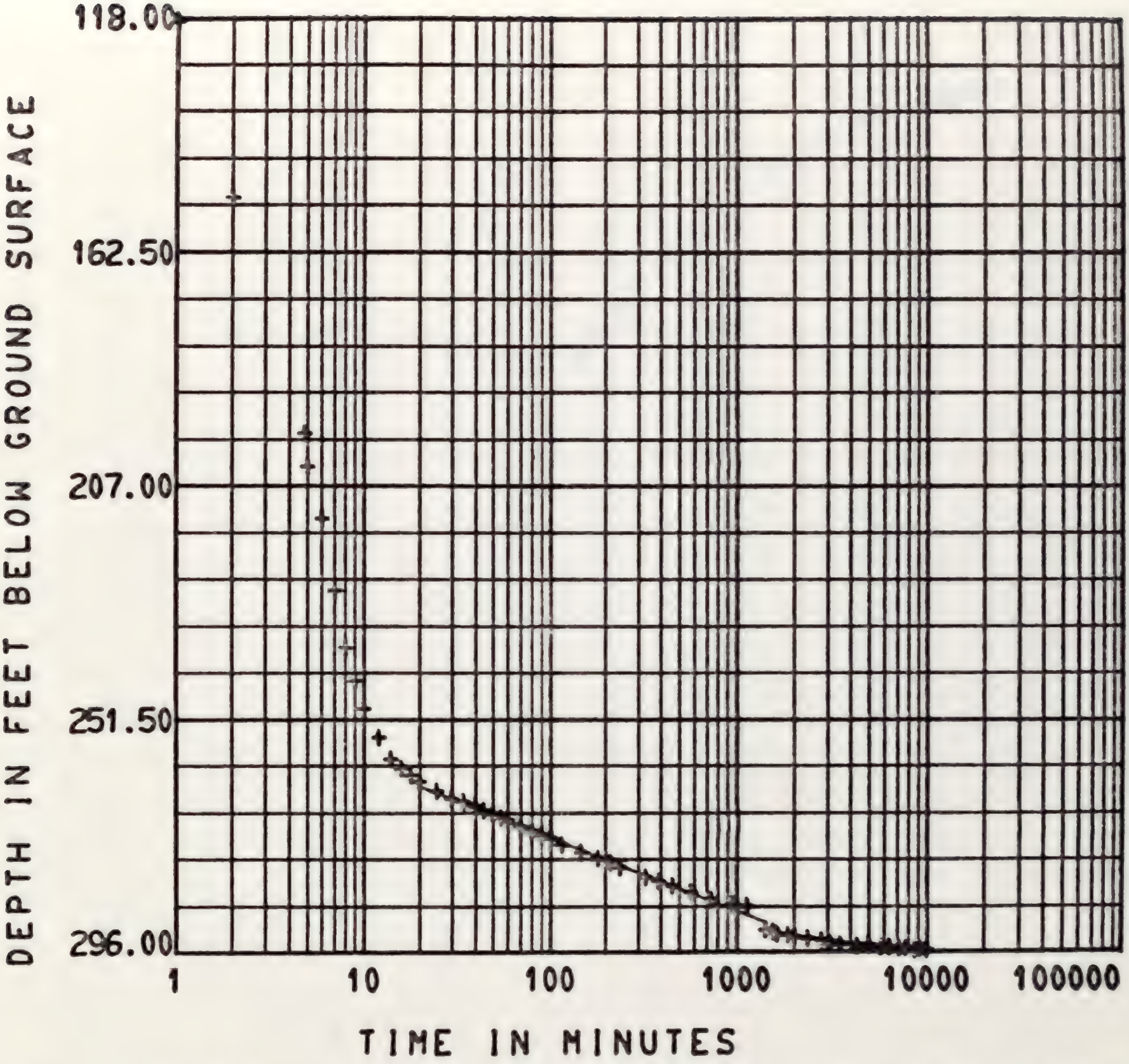
CE 702 GS-19 LOWR RECOVERY



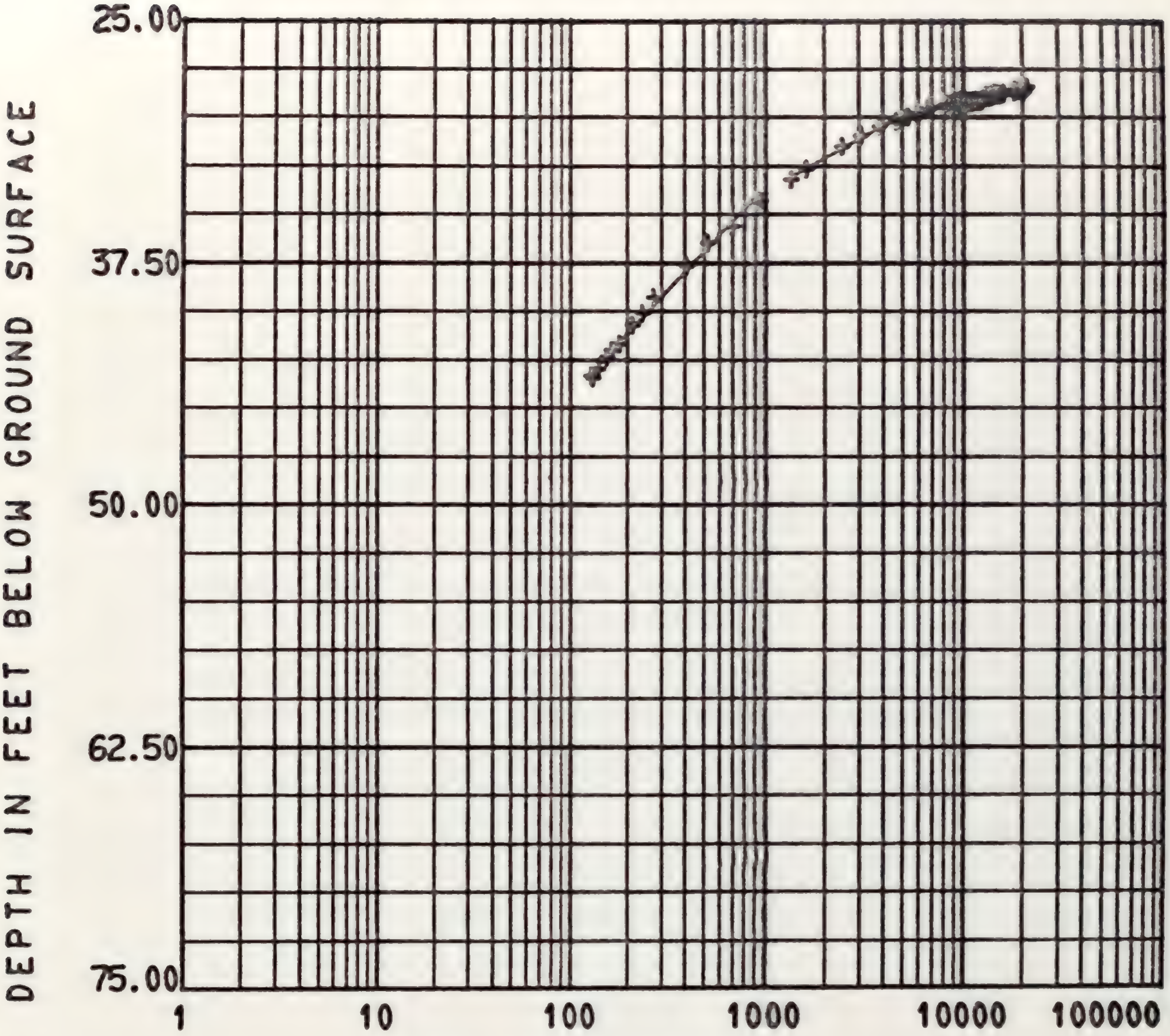
CE 705A CE 705A UPPR DRAWDOWN



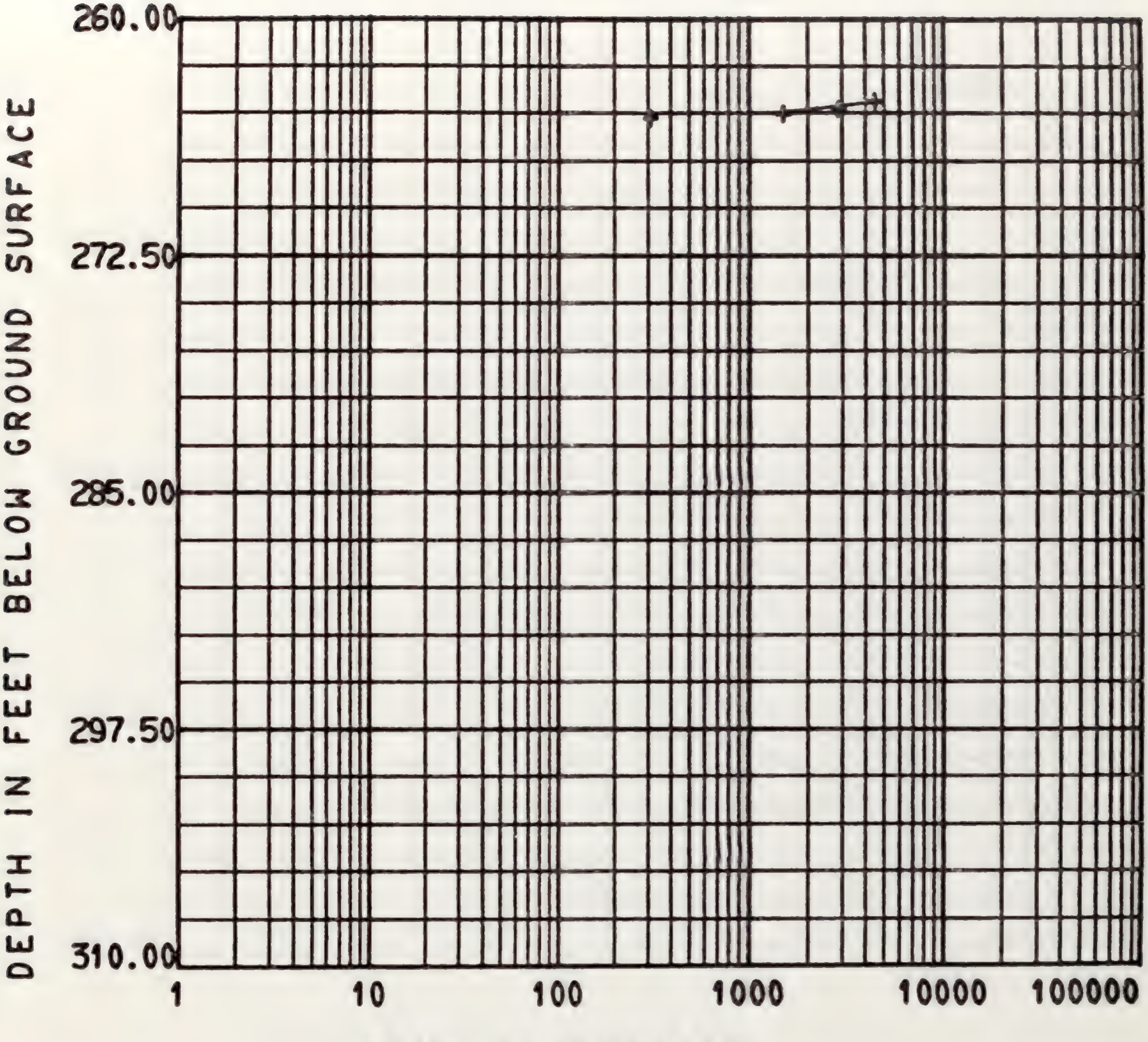
CE 705A CE 705A UPPR RECOVERY



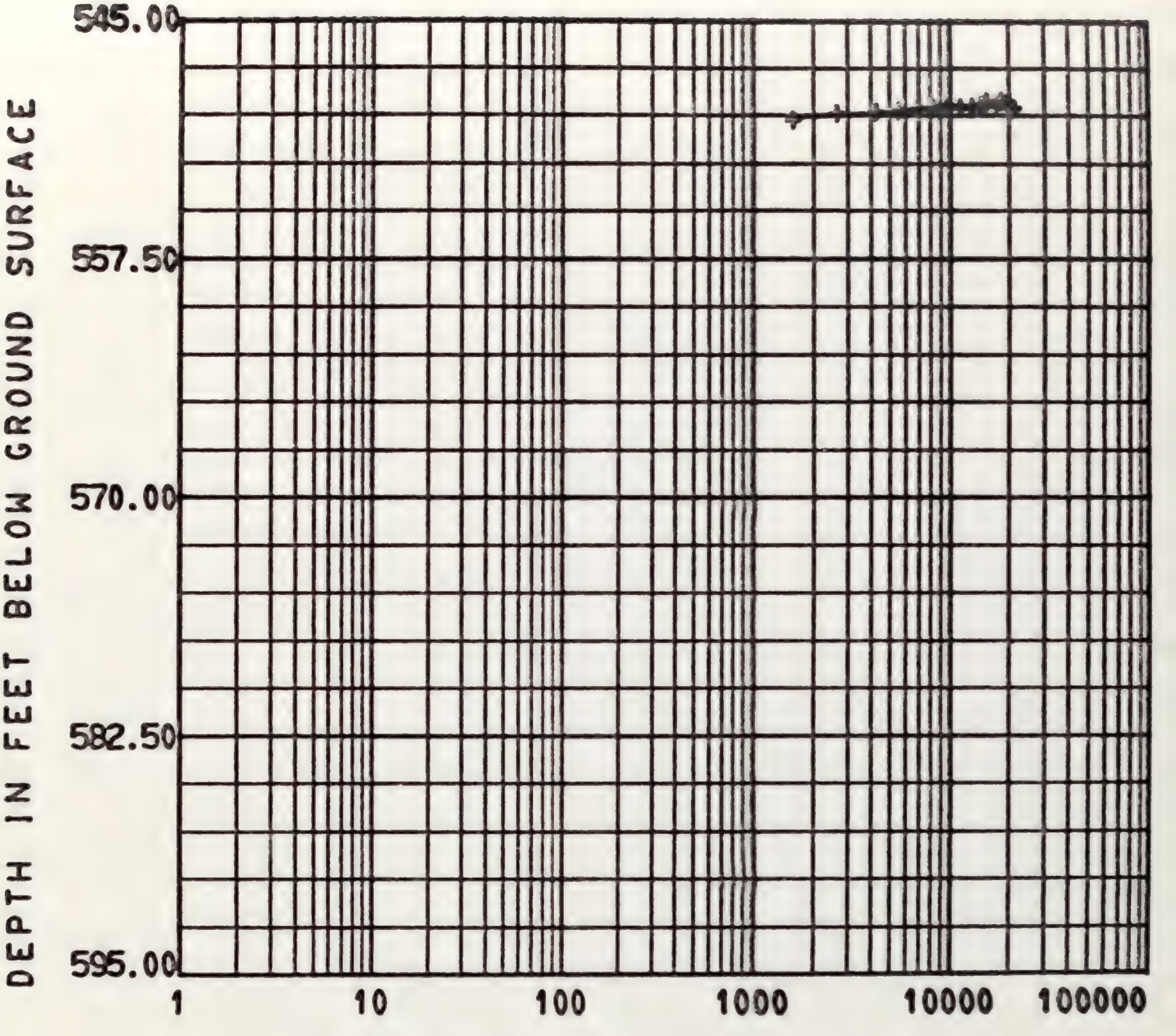
CE 705A CE 705A UPPR DRAWDOWN



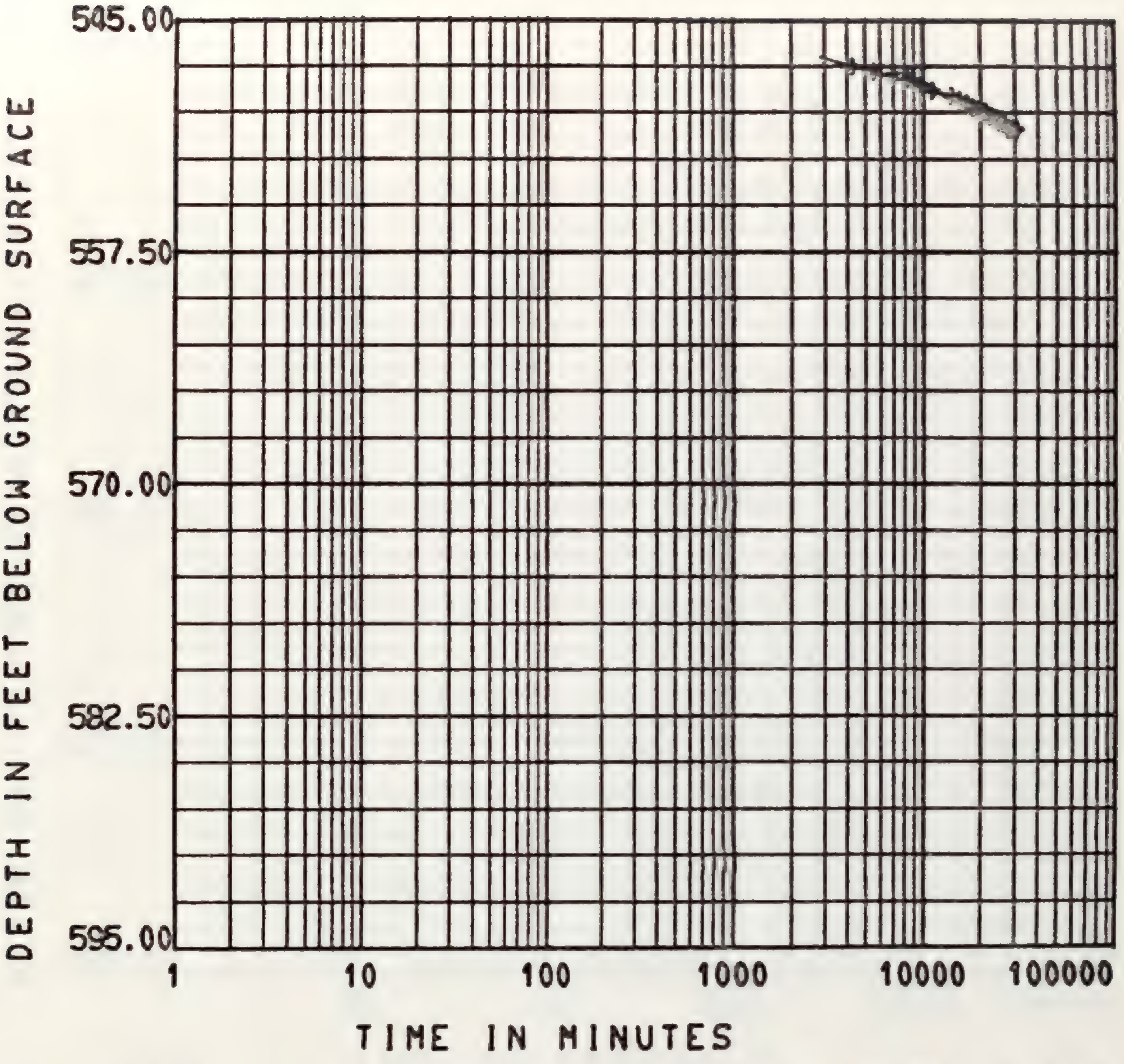
CE 705A CE 705A UPPR RECOVERY



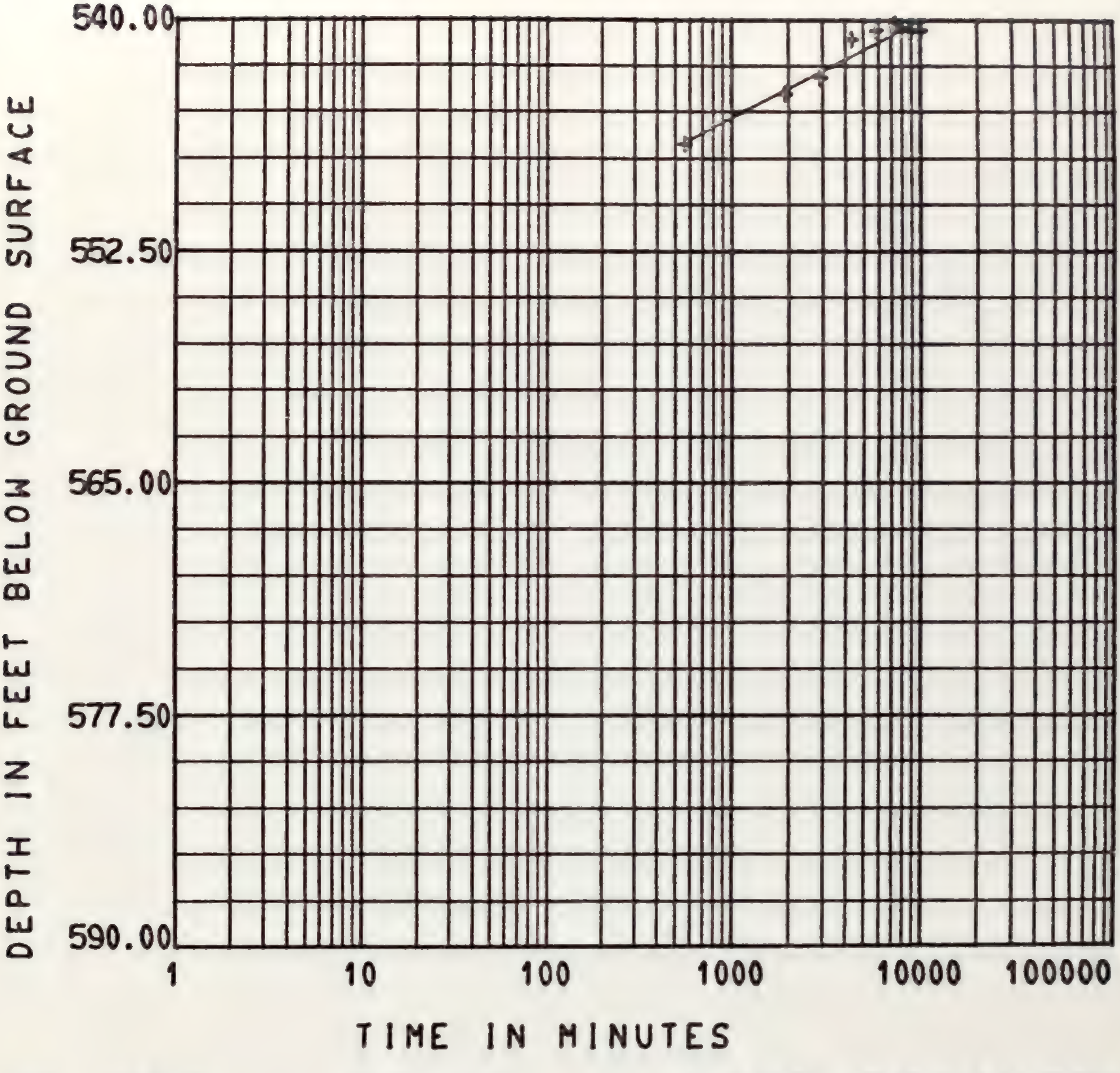
CE 707 GS-12 UPPR RECOVERY



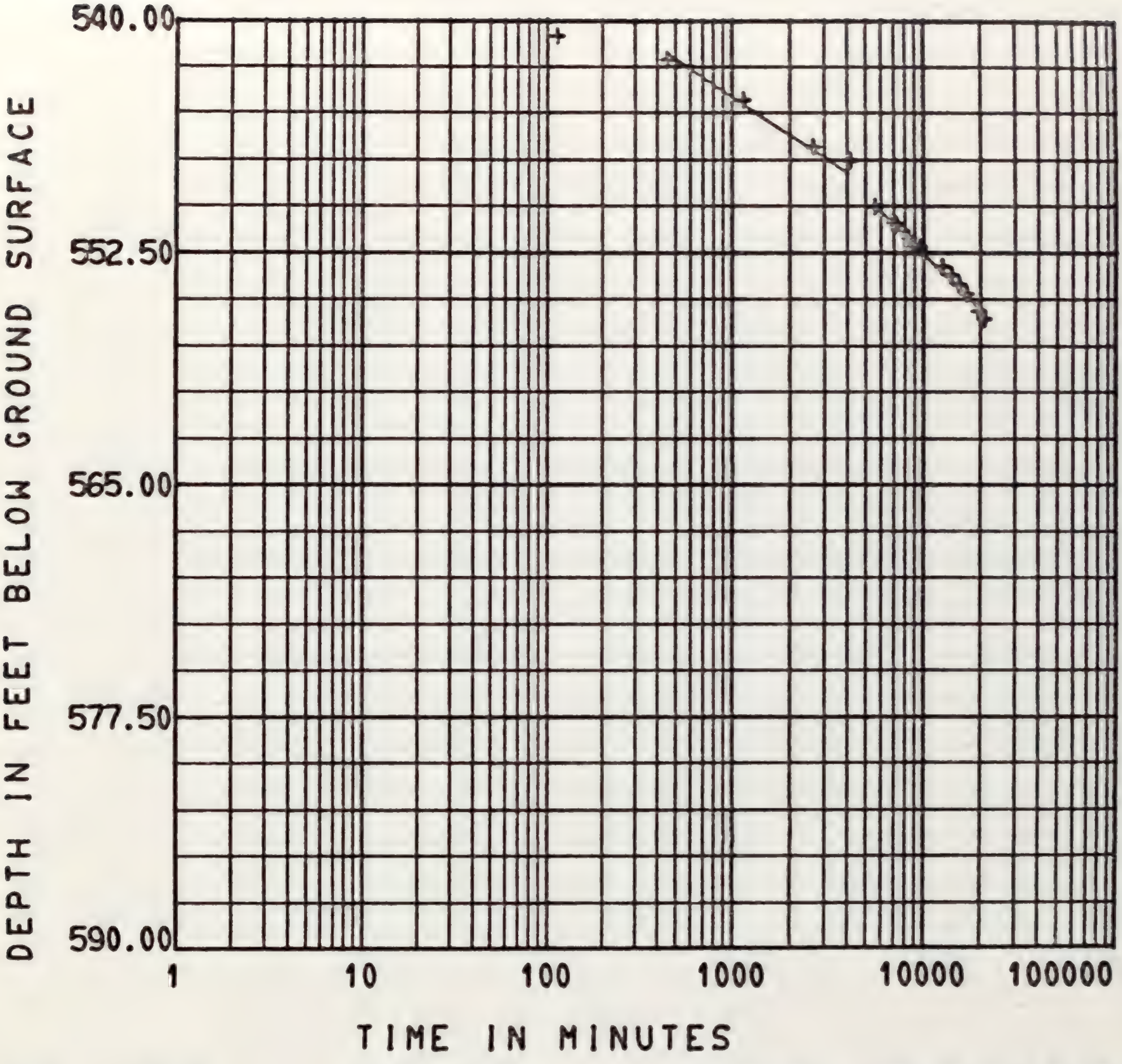
CE 707 GS-16 LOWR RECOVERY



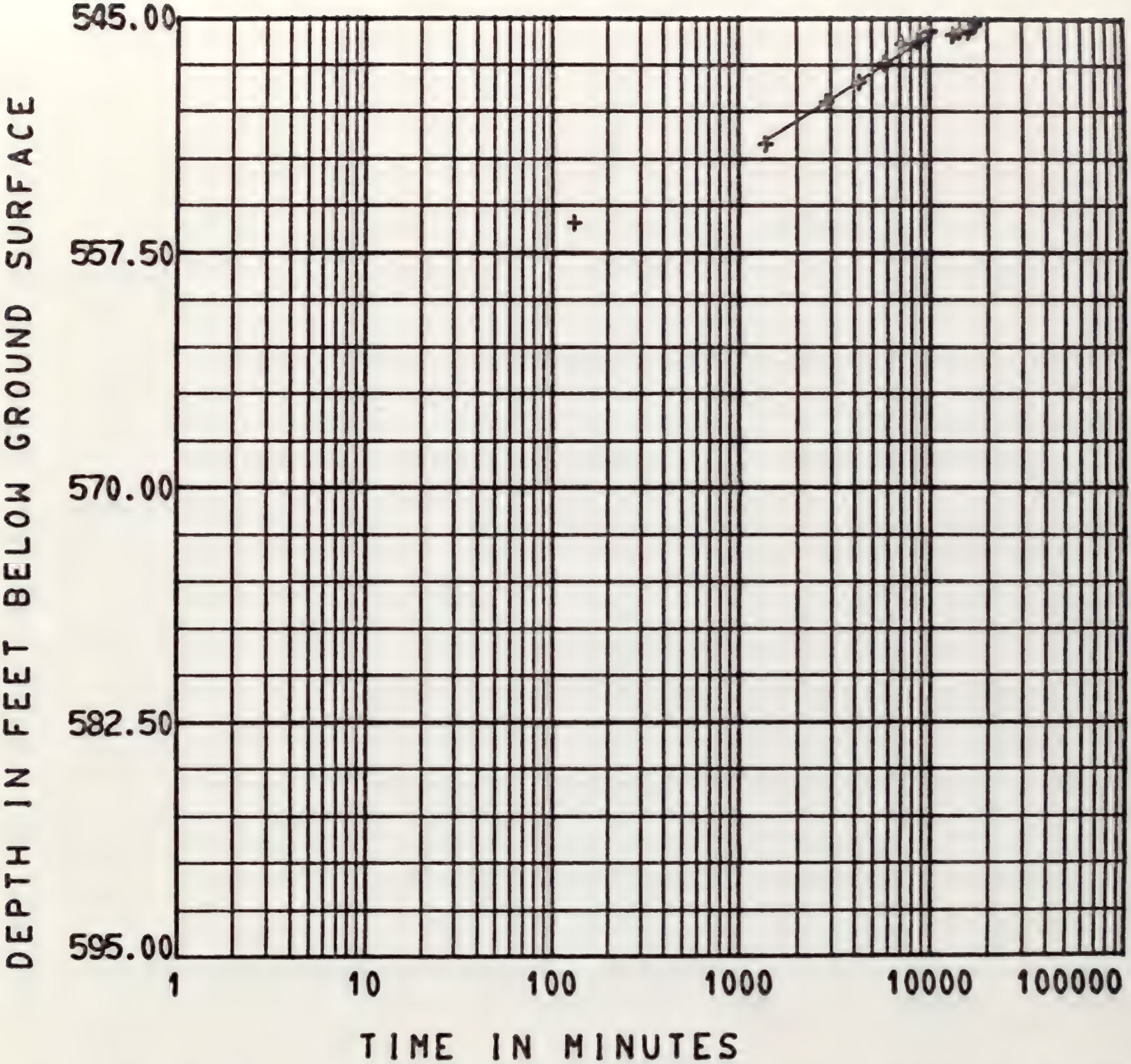
CE 707 GS-16 LOWR DRAWDOWN



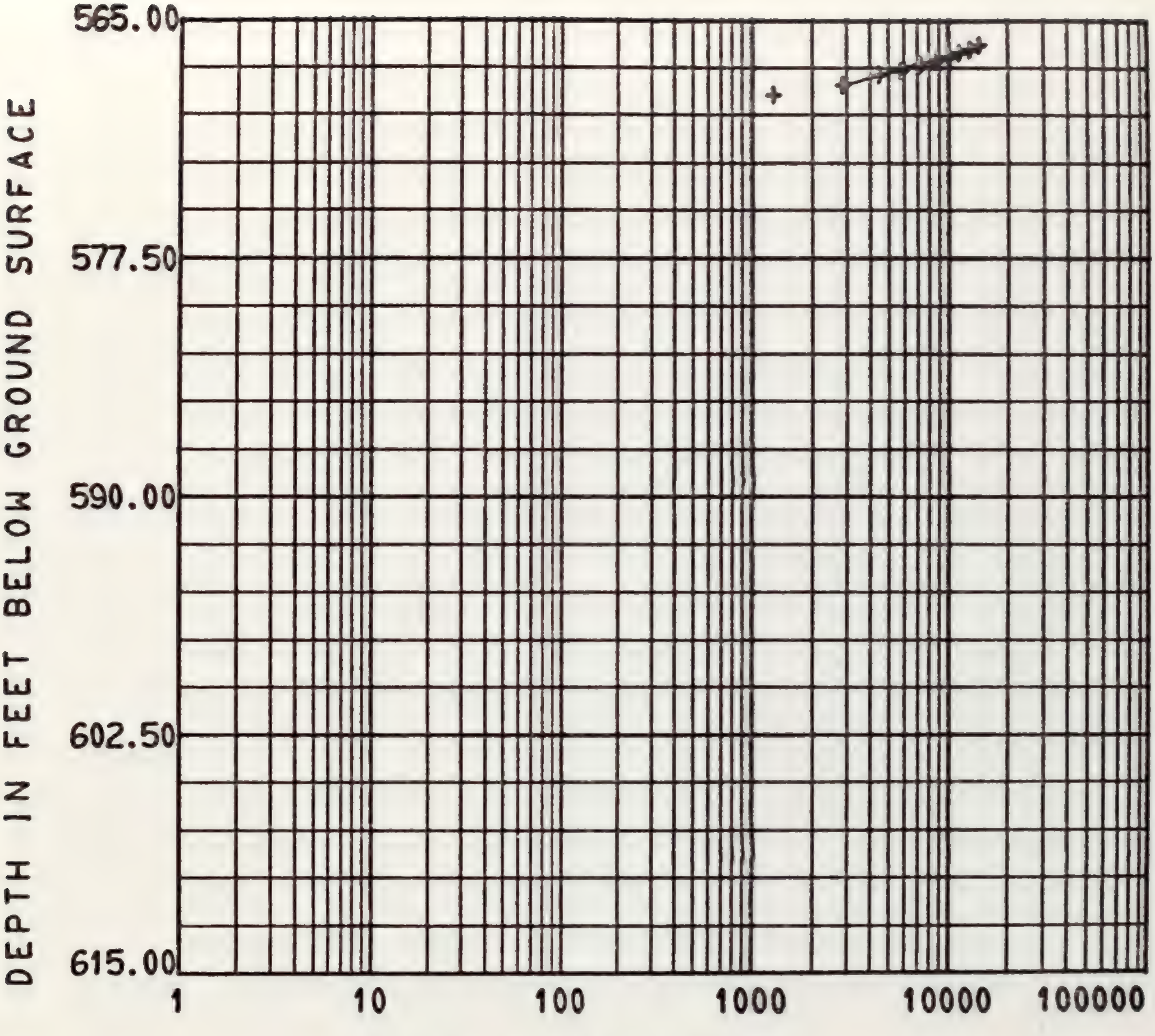
CE 707 GS-17 LOWR RECOVERY



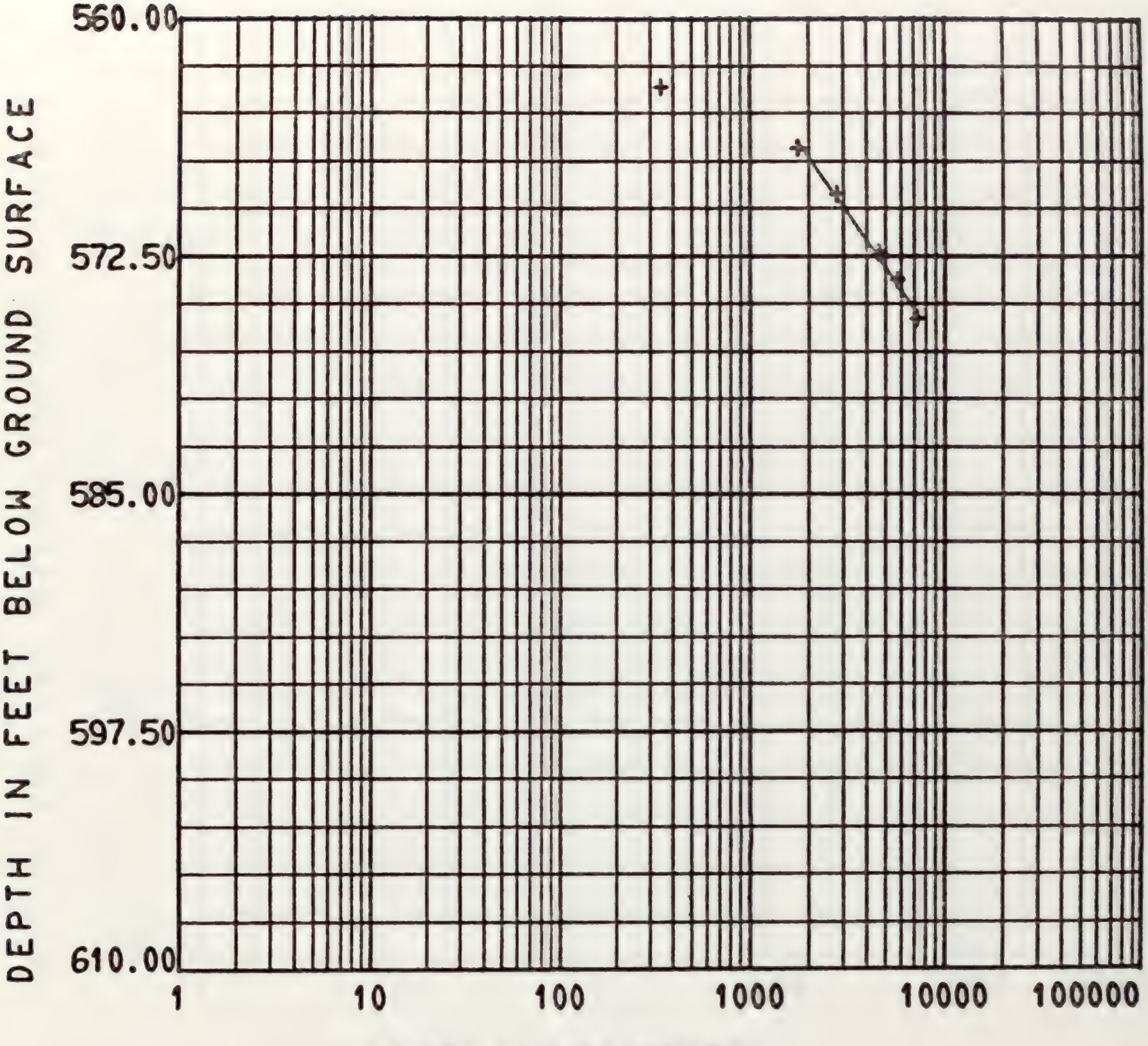
CE 707 GS-17 LOWR DRAWDOWN



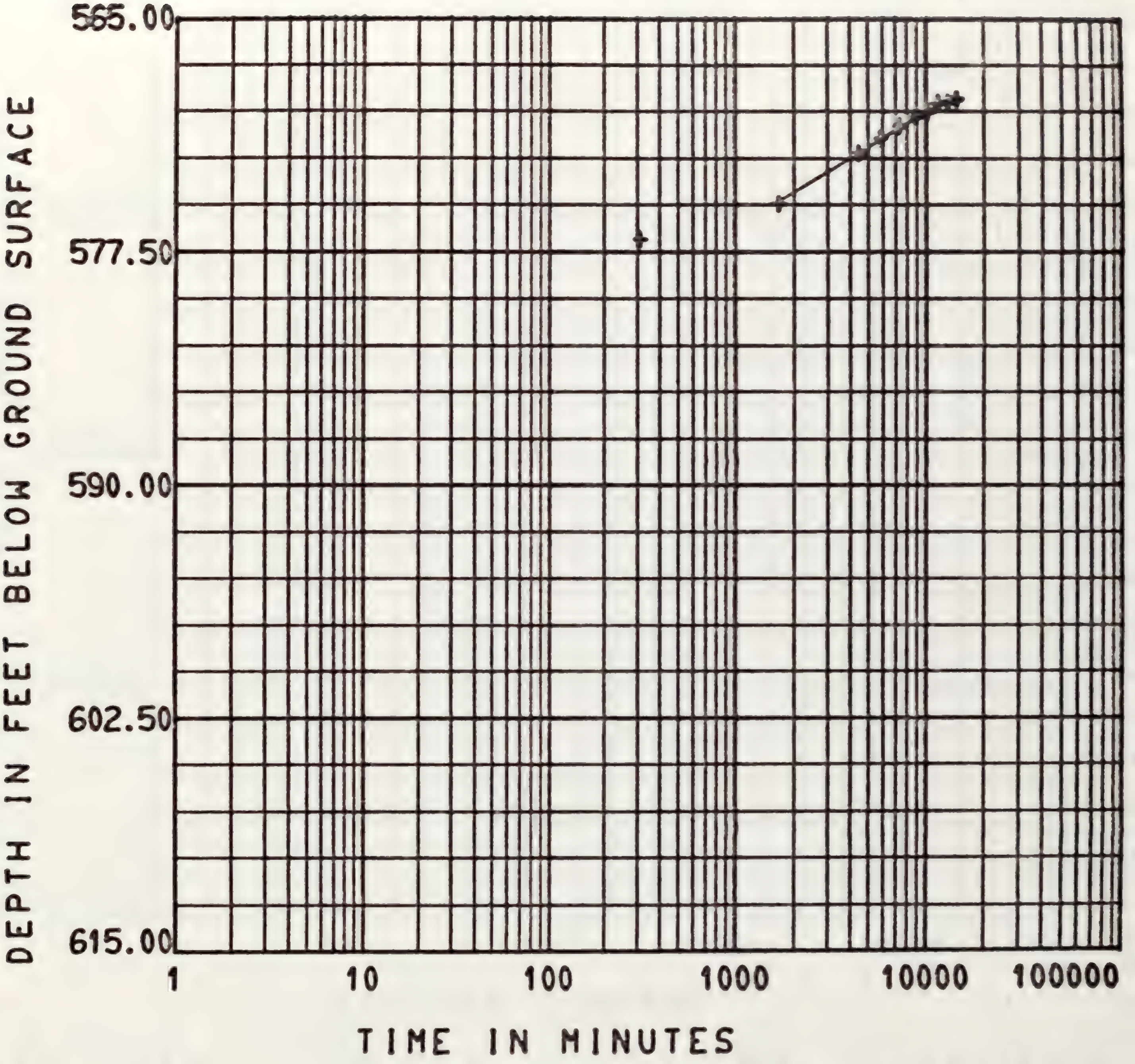
CE 707 GS-17 LOWR RECOVERY



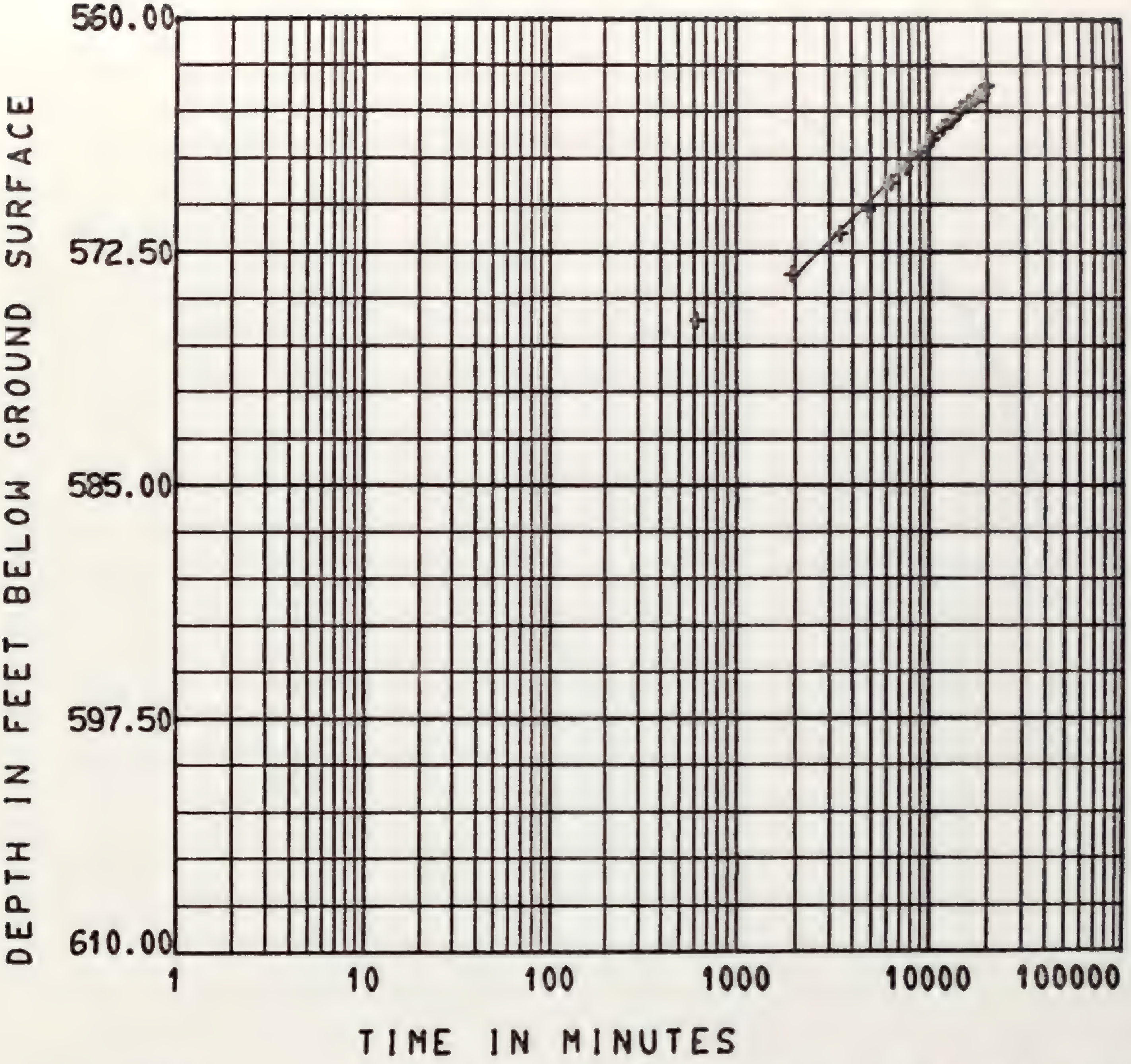
CE 707 GS-18 LOWR RECOVERY



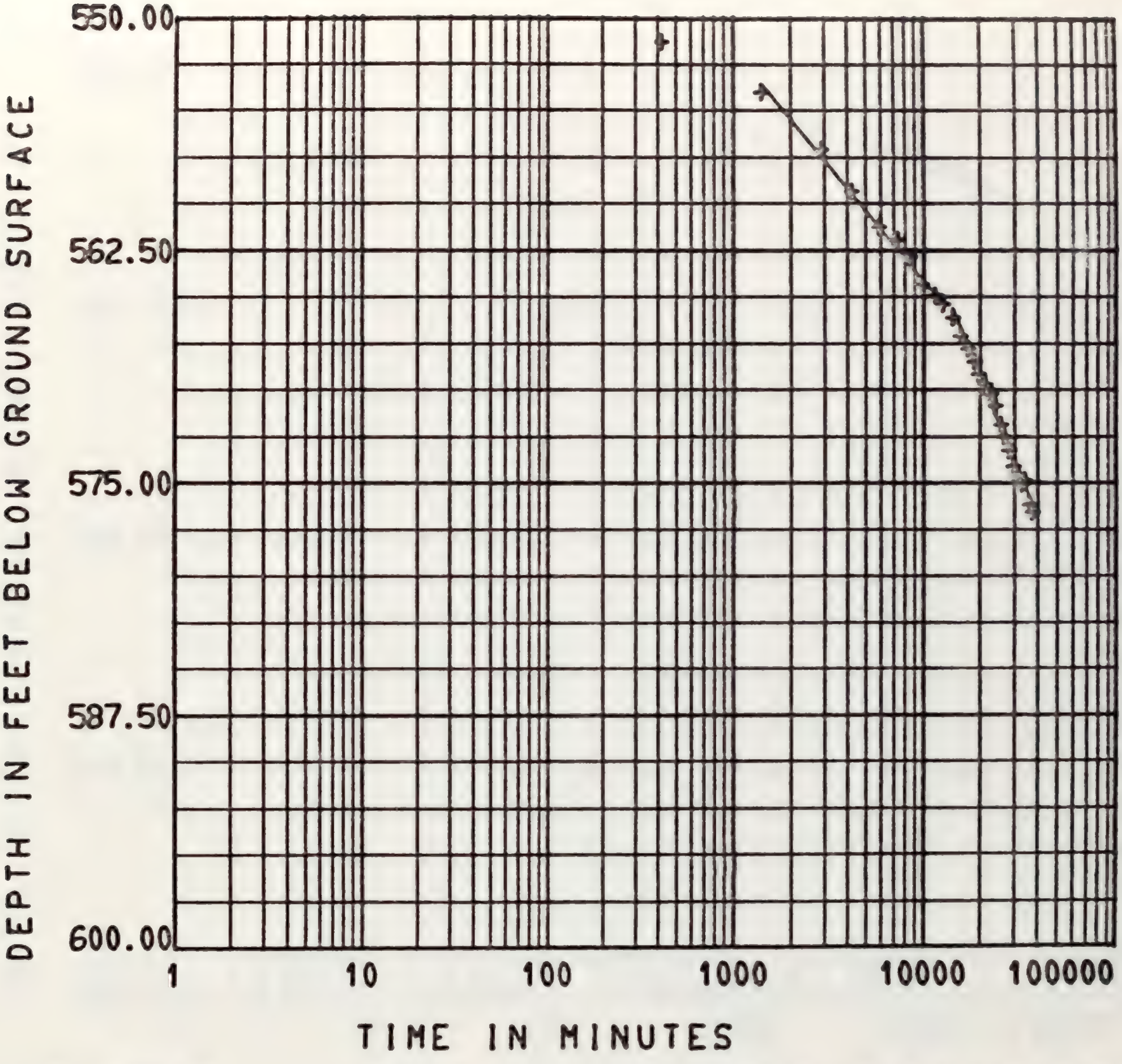
CE 707 GS-19 LOWR DRAWDOWN



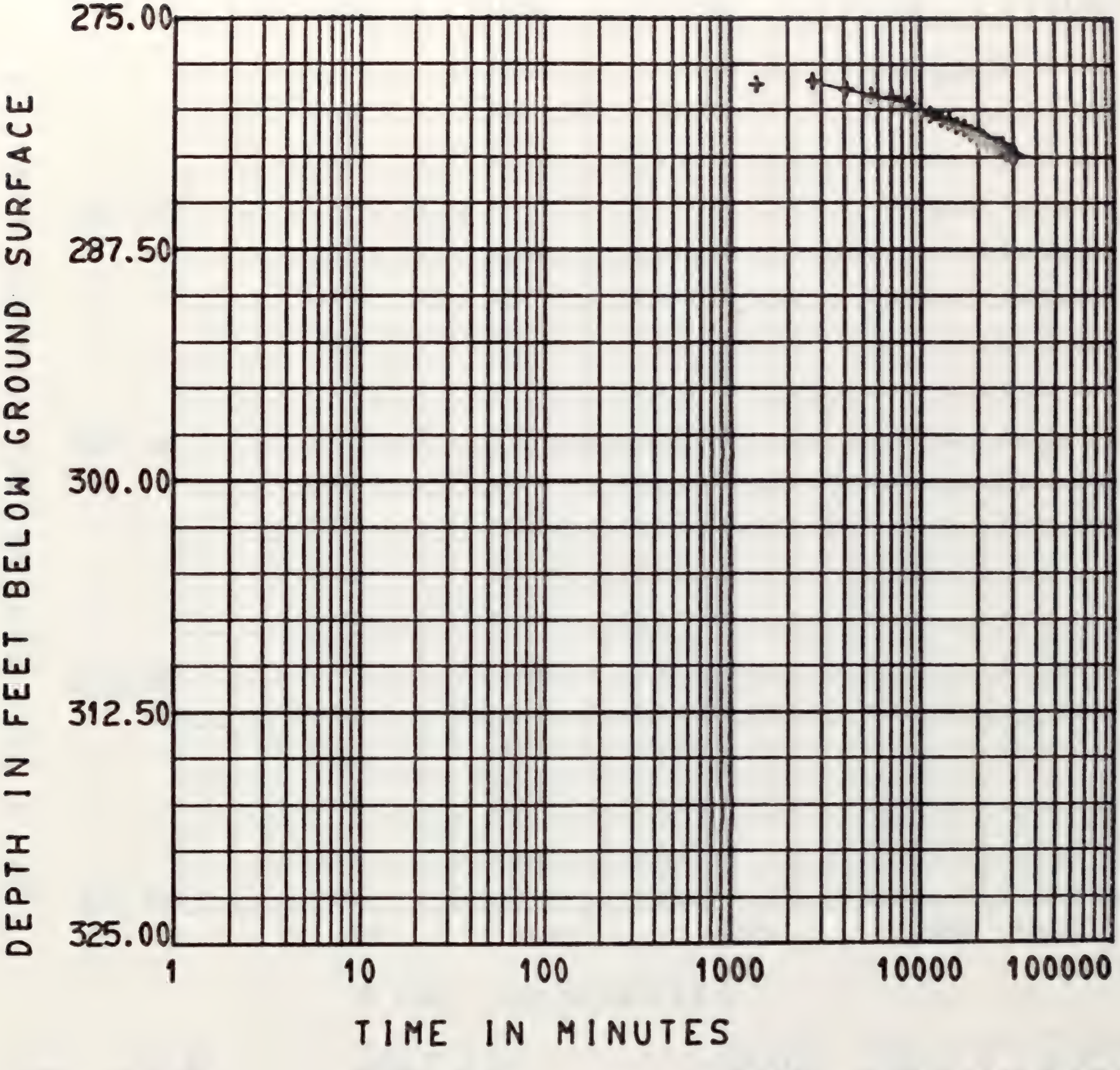
CE 707 GS-19 LOWR RECOVERY



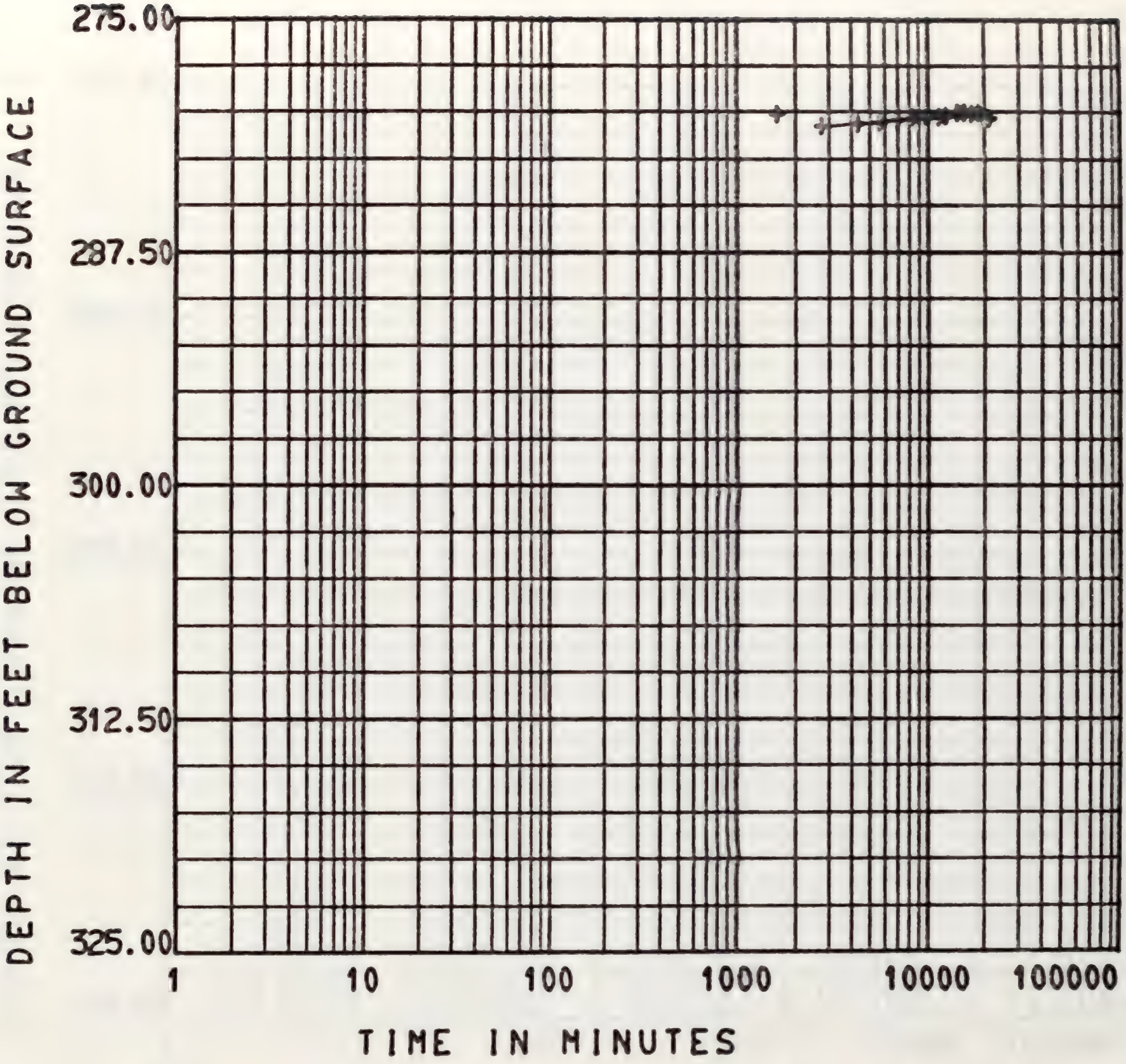
CE 707 GS-19 LOWR RECOVERY



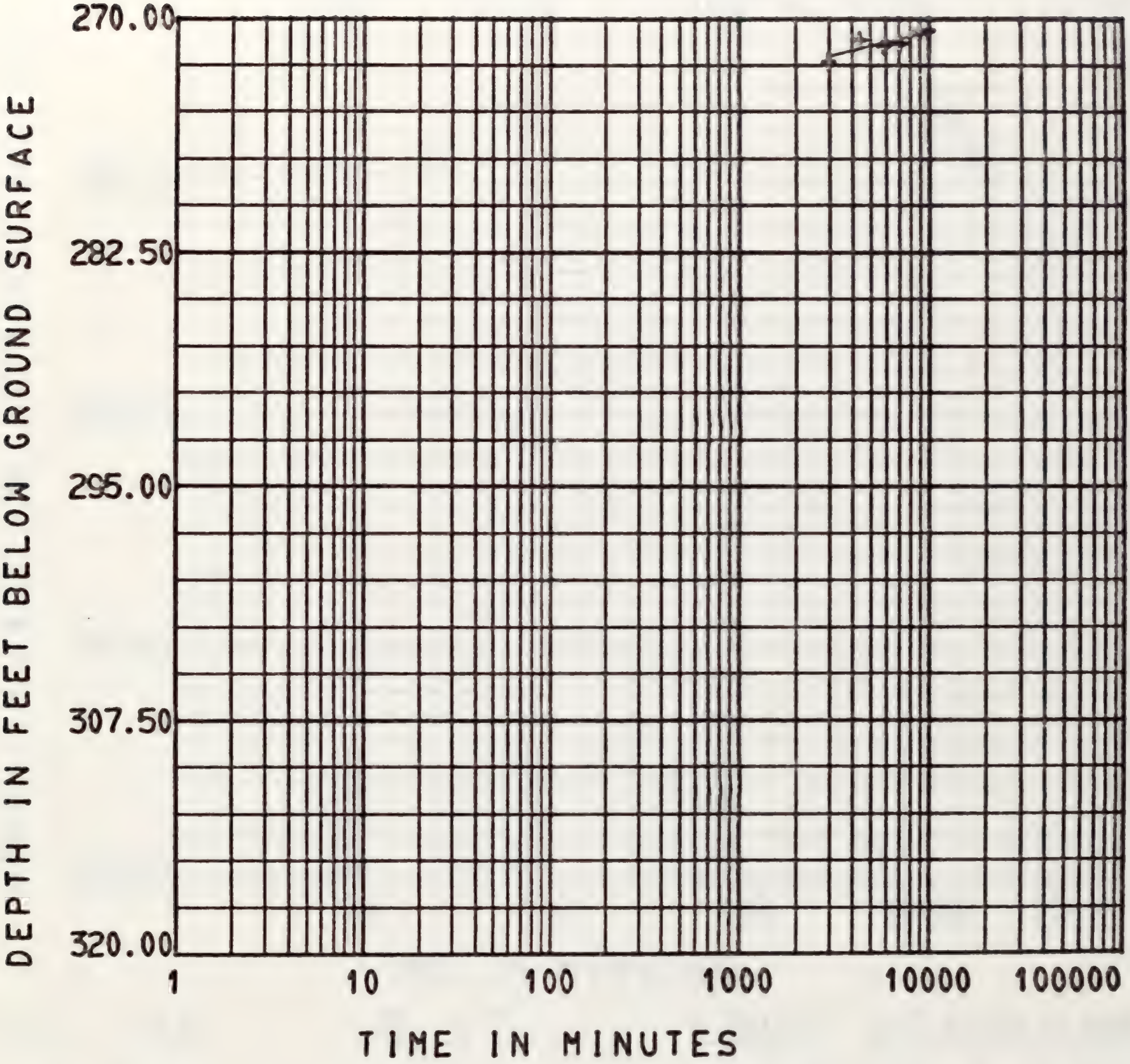
CE 707 GS-19 LOWR DRAWDOWN



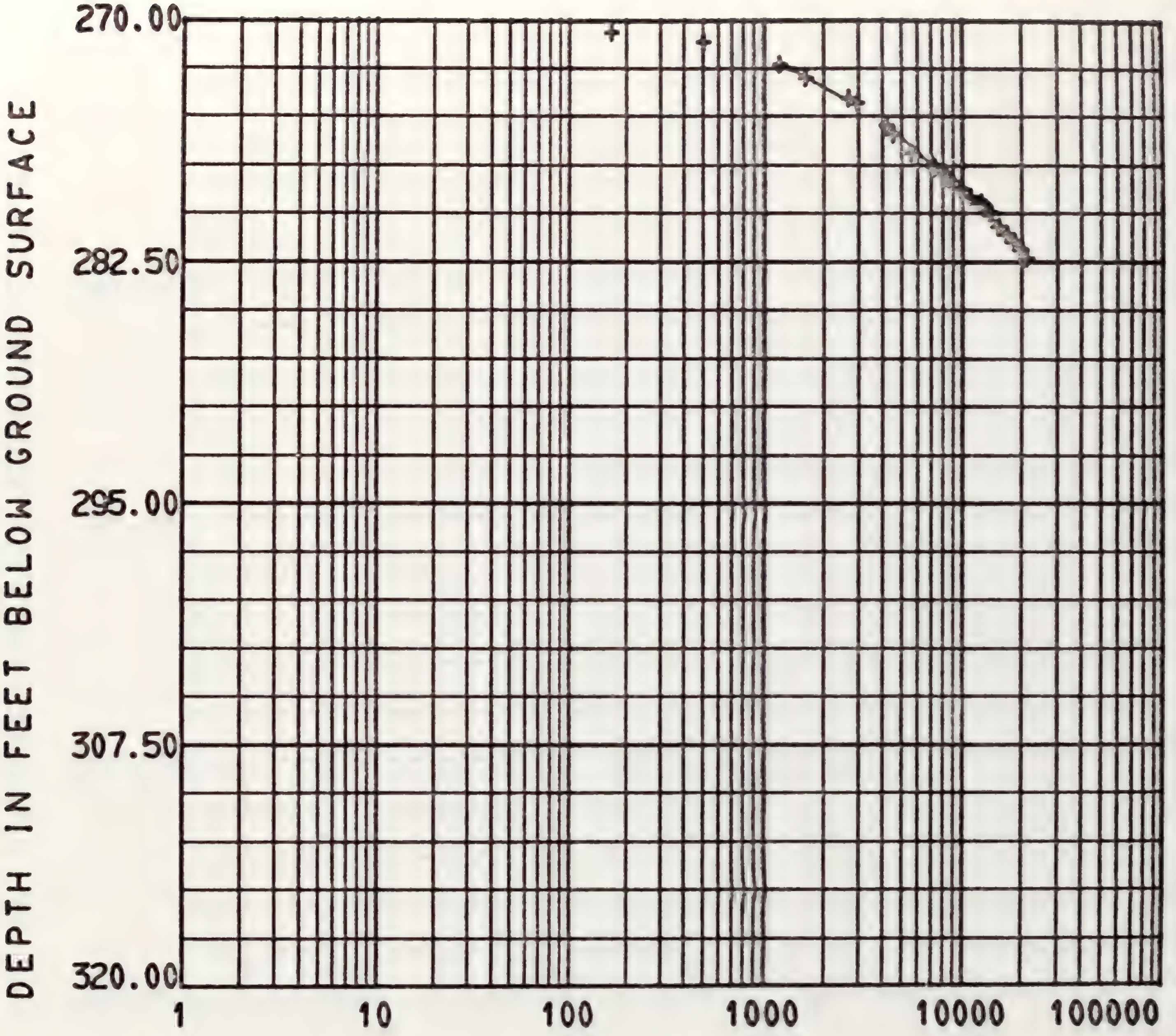
CE 708 GS-16 LOWR DRAWDOWN



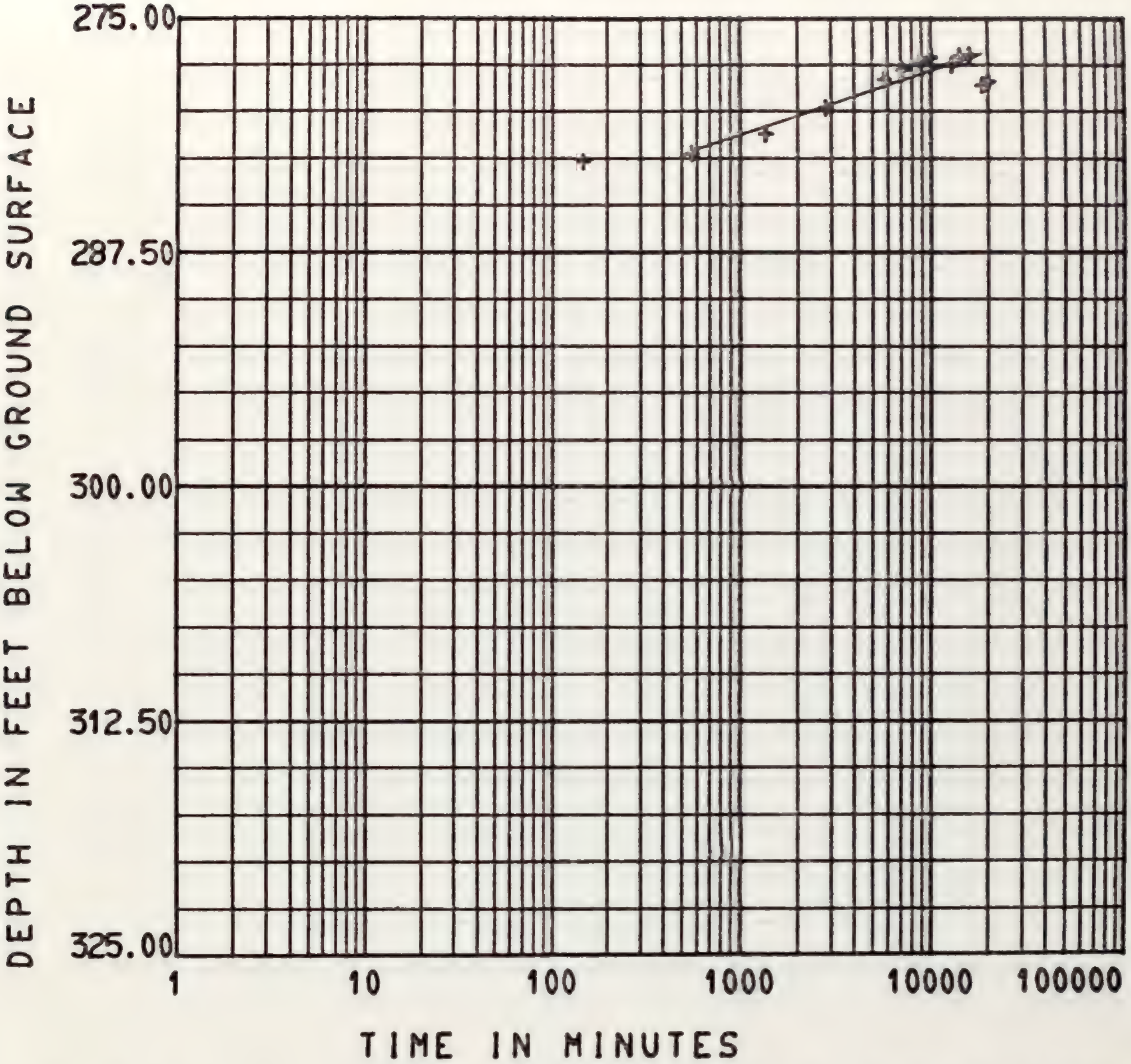
CE 708 GS-16 LOWR RECOVERY



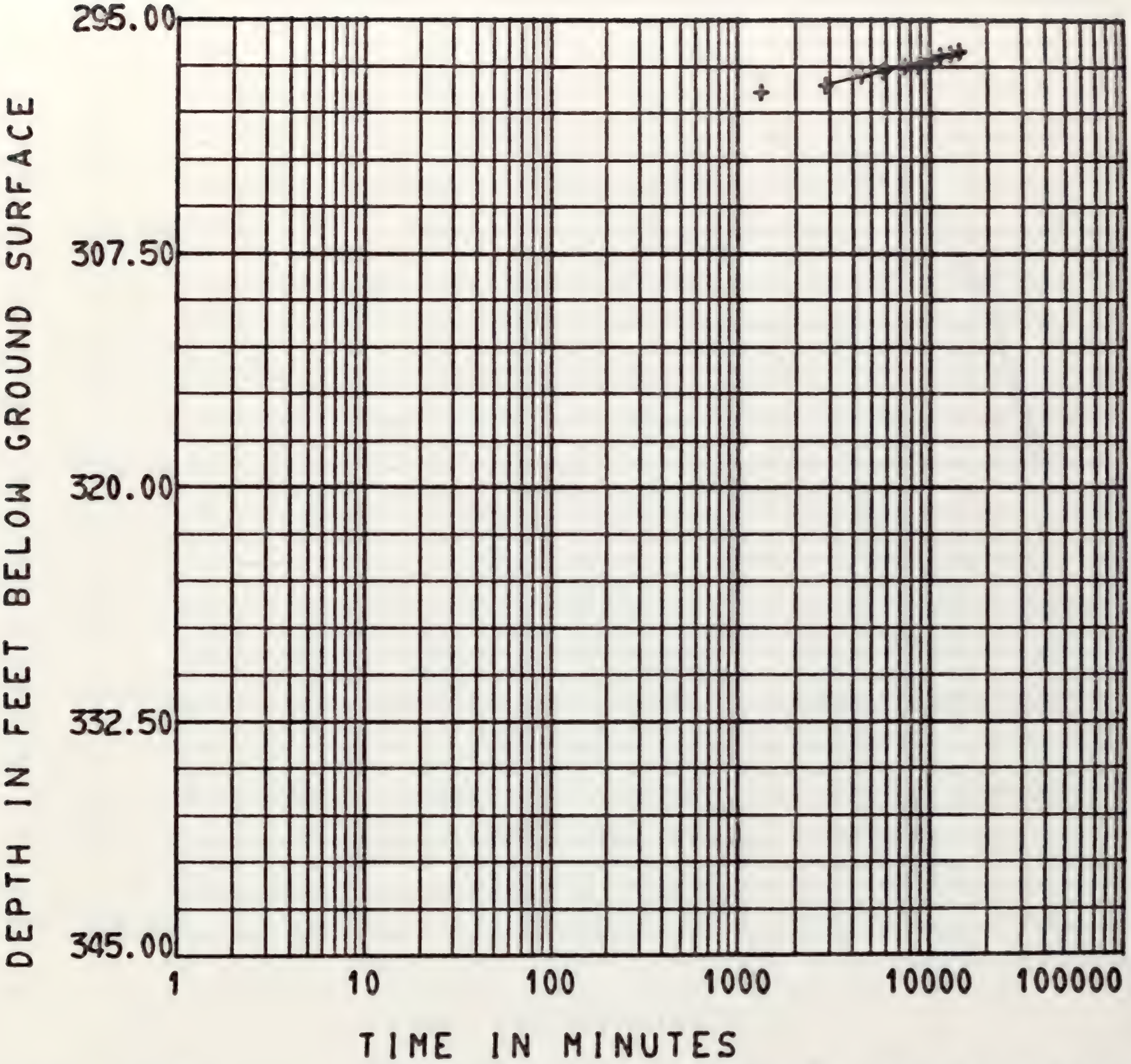
CE 708 GS-17 LOWR RECOVERY



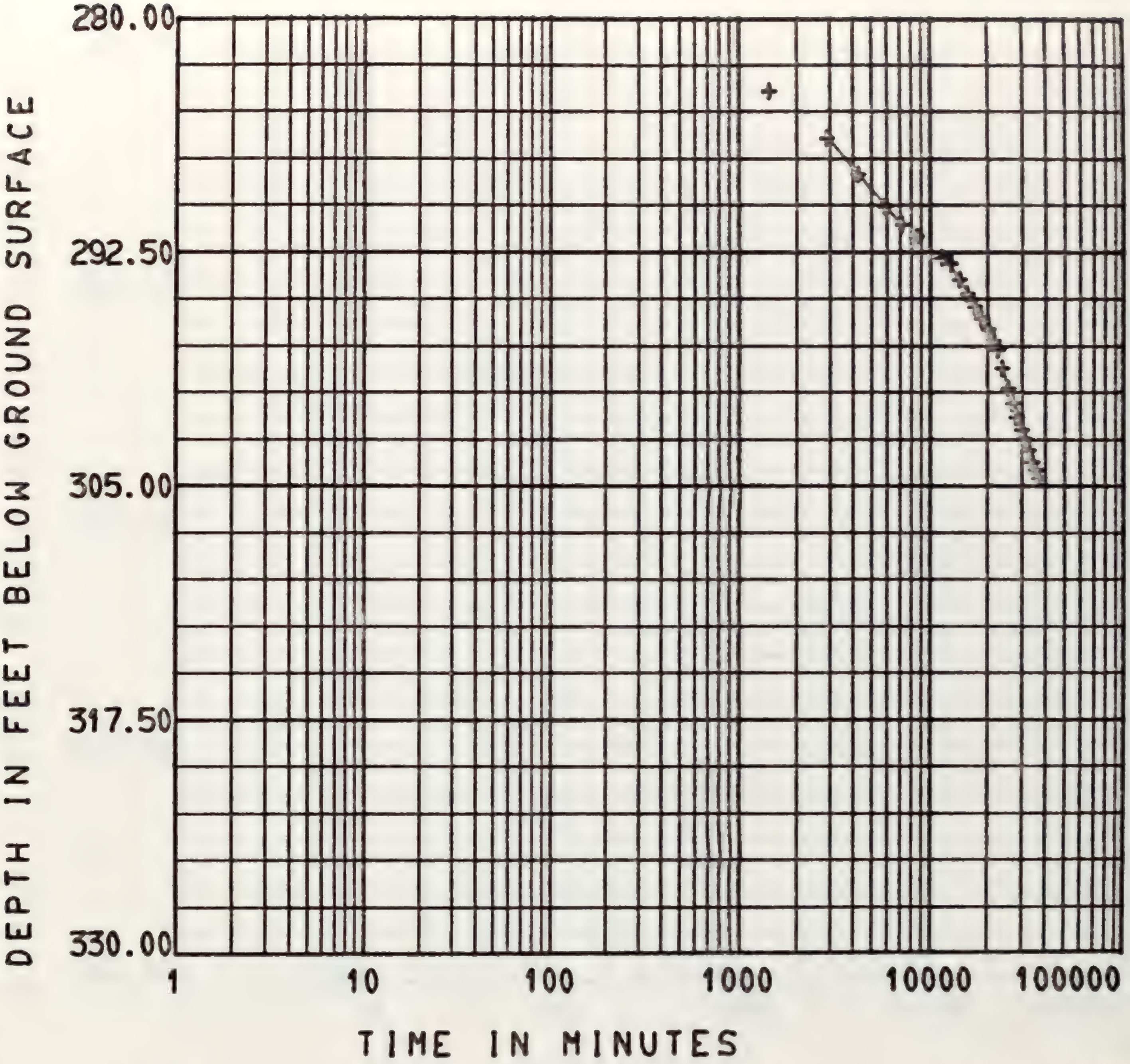
CE 708 GS-17 LOWR DRAWDOWN



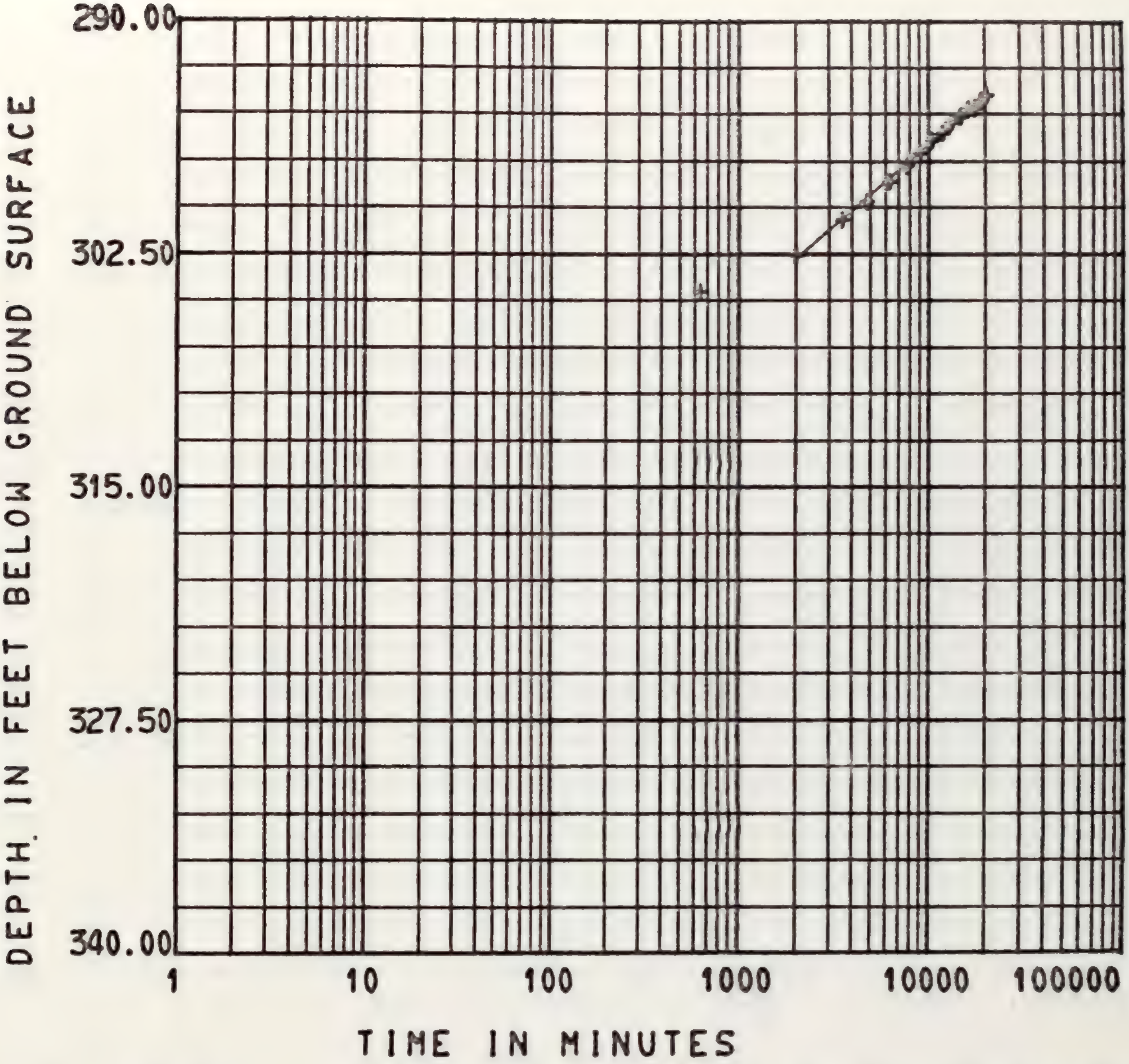
CE 708 GS-17 LOWR RECOVERY



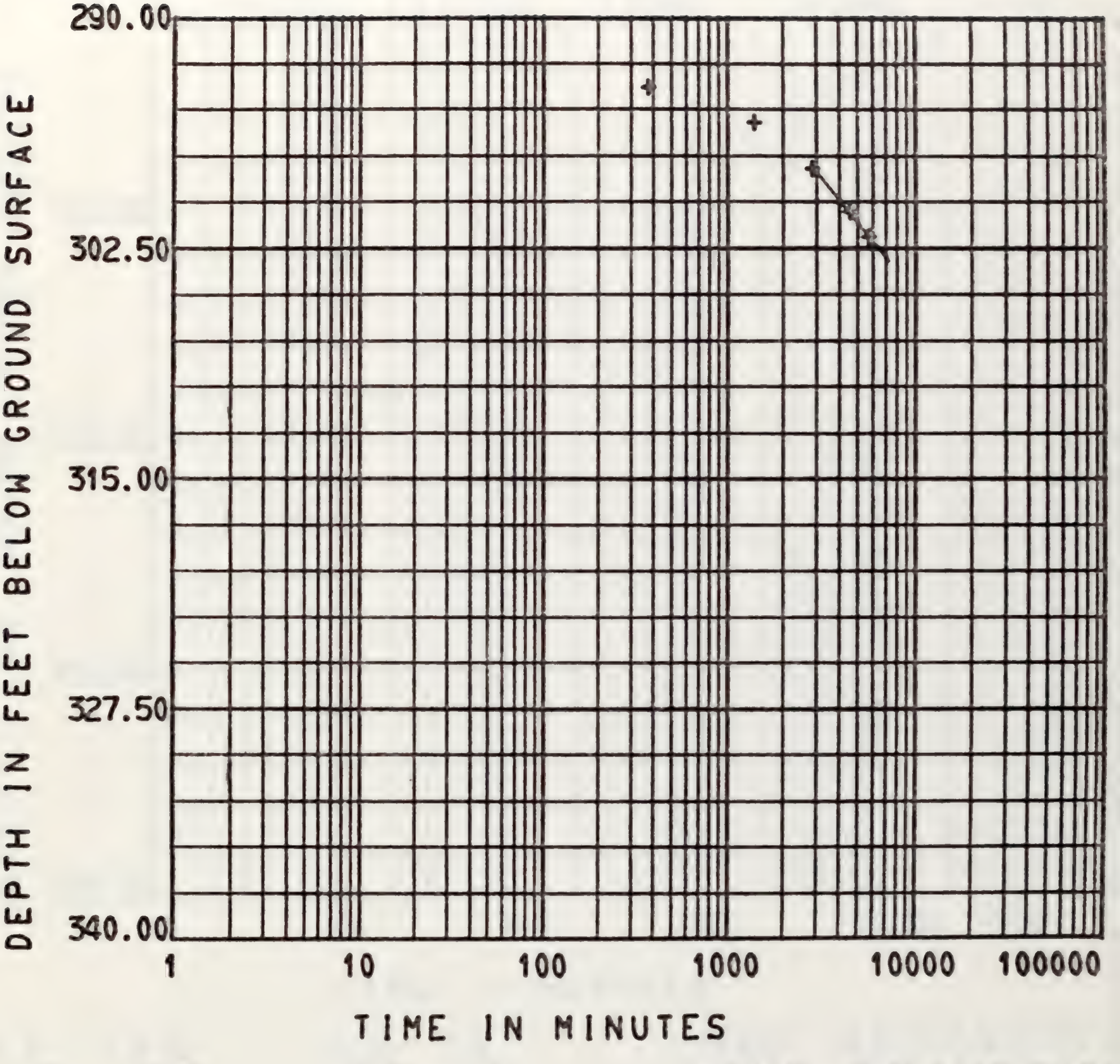
CE 708 GS-18 LOWR RECOVERY



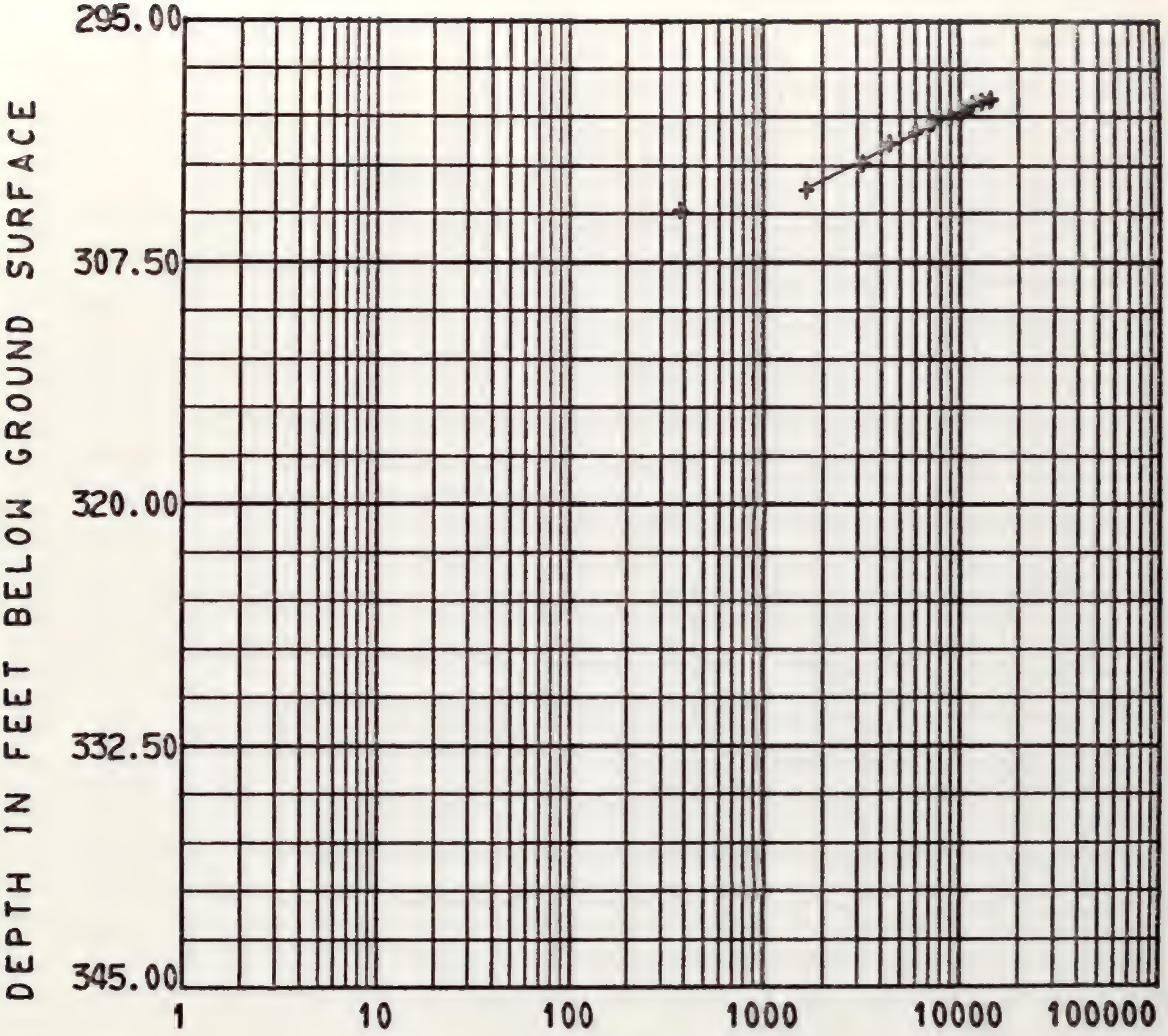
CE 708 GS-19 LOWR DRAWDOWN



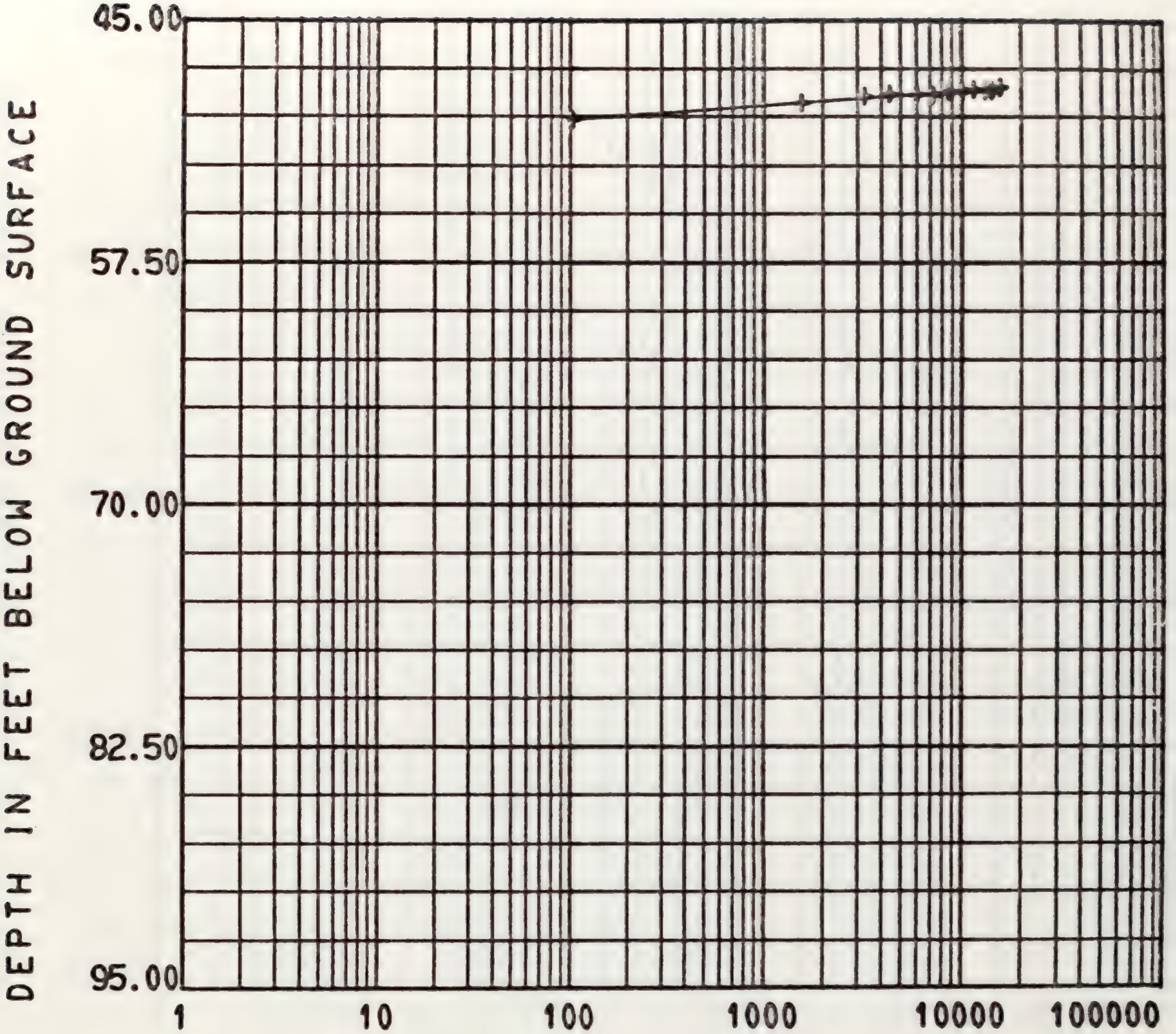
CE 708 GS-19 LOWR RECOVERY



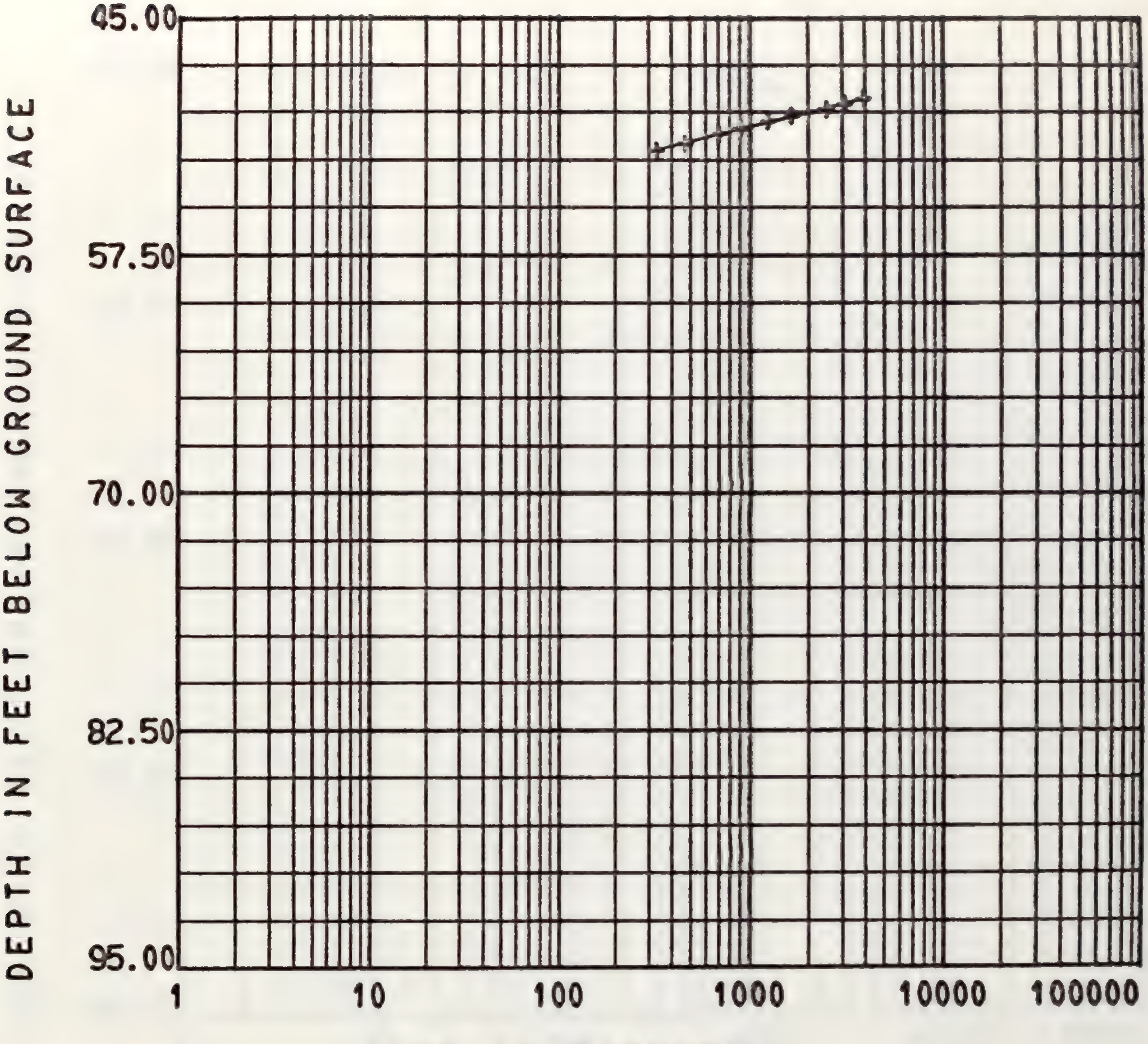
CE 708 GS-19 LOWR DRAWDOWN



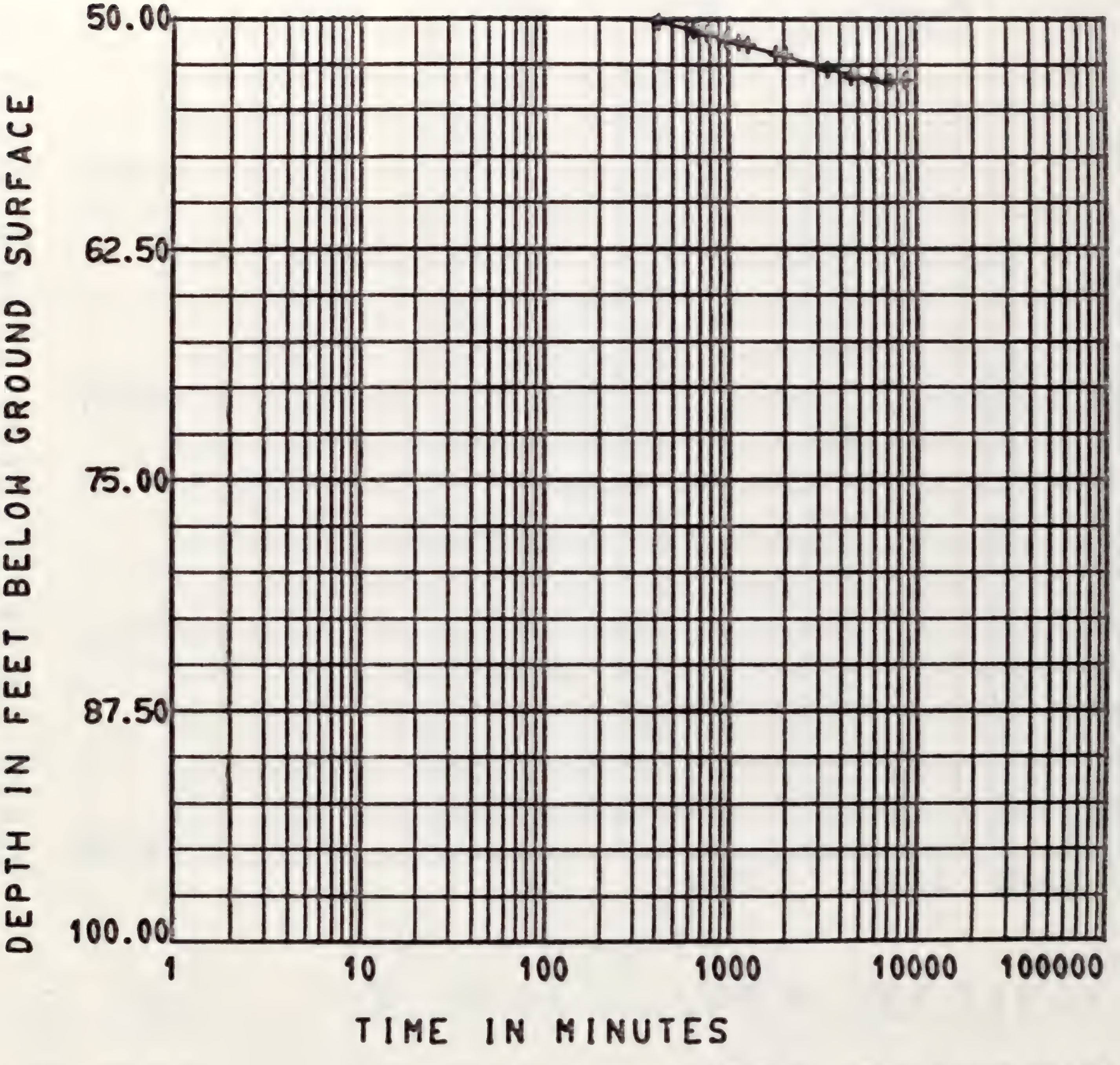
CE 708 GS-19 LOWR RECOVERY



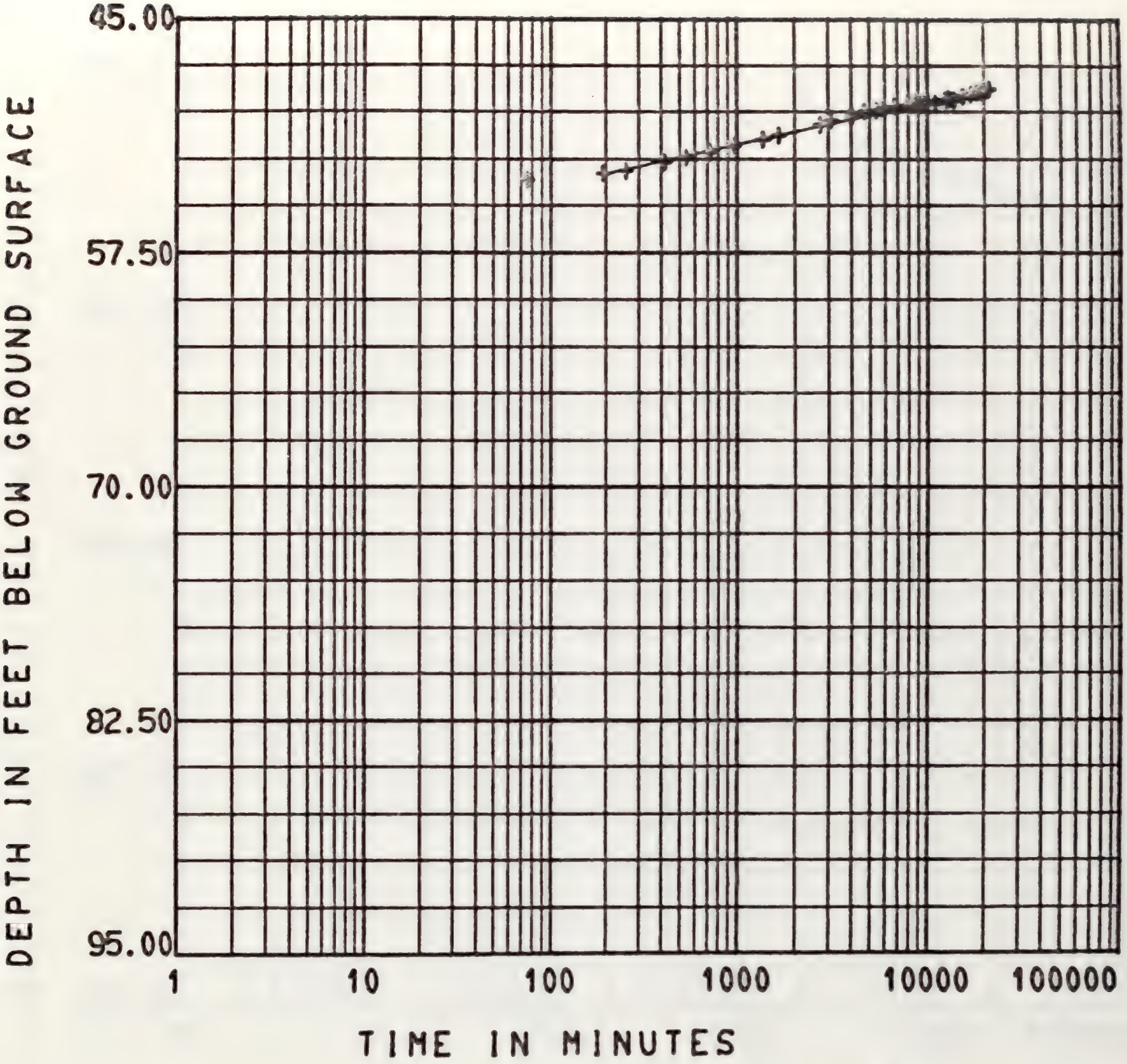
CE 709 CE 705A UPPR RECOVERY



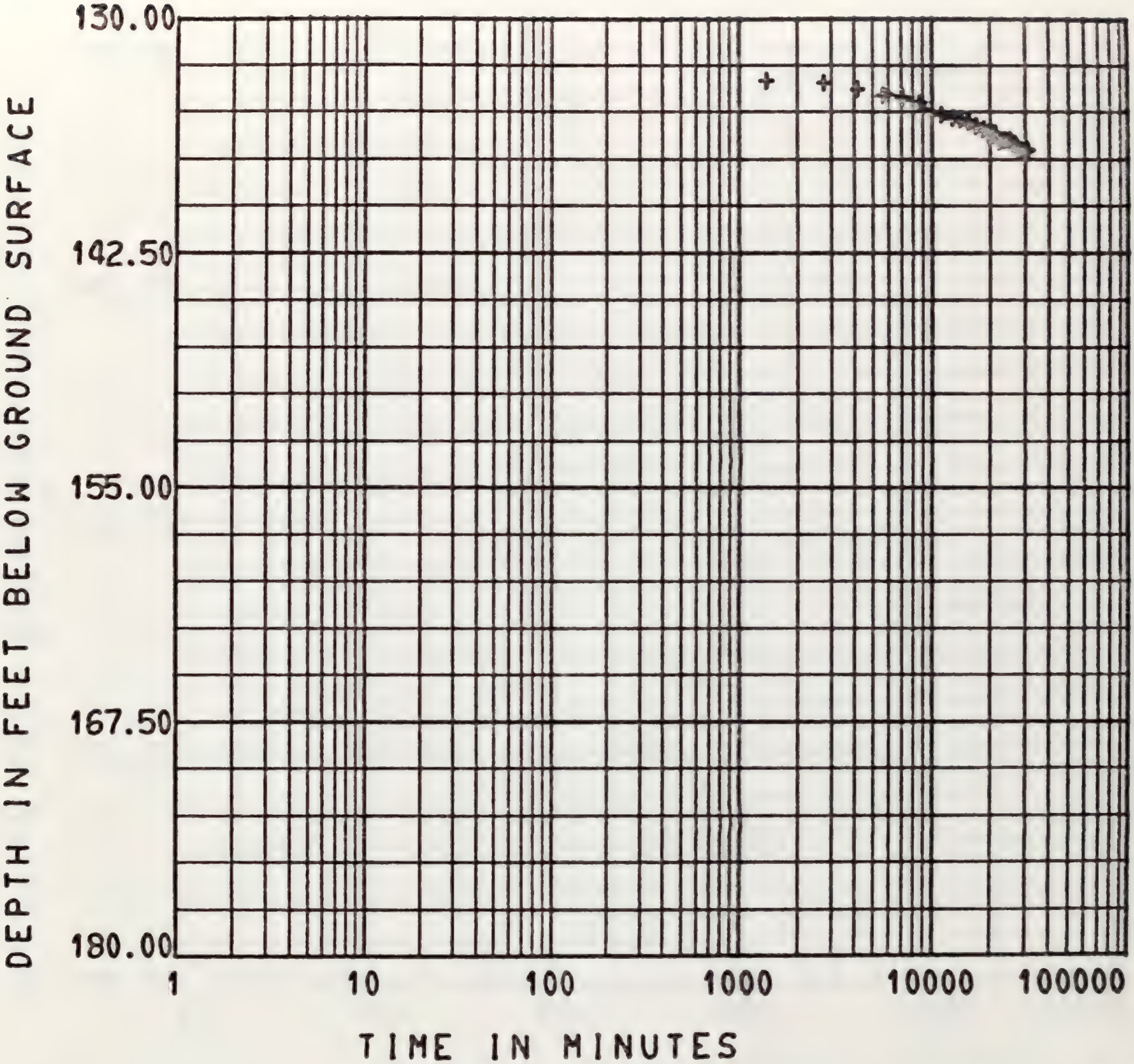
CE 709 CE 705A UPPR RECOVERY



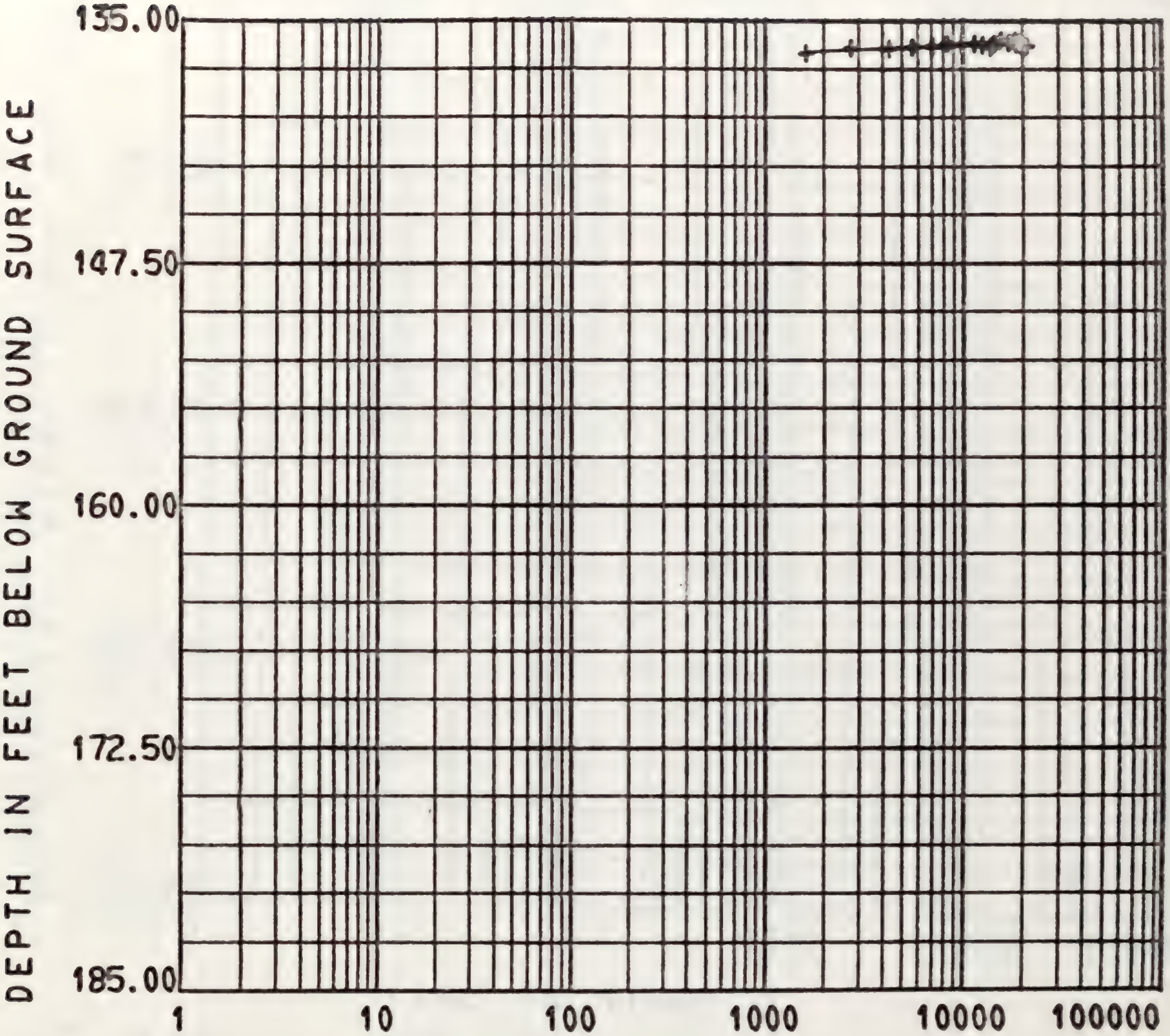
CE 709 CE 705A UPPR DRAWDOWN



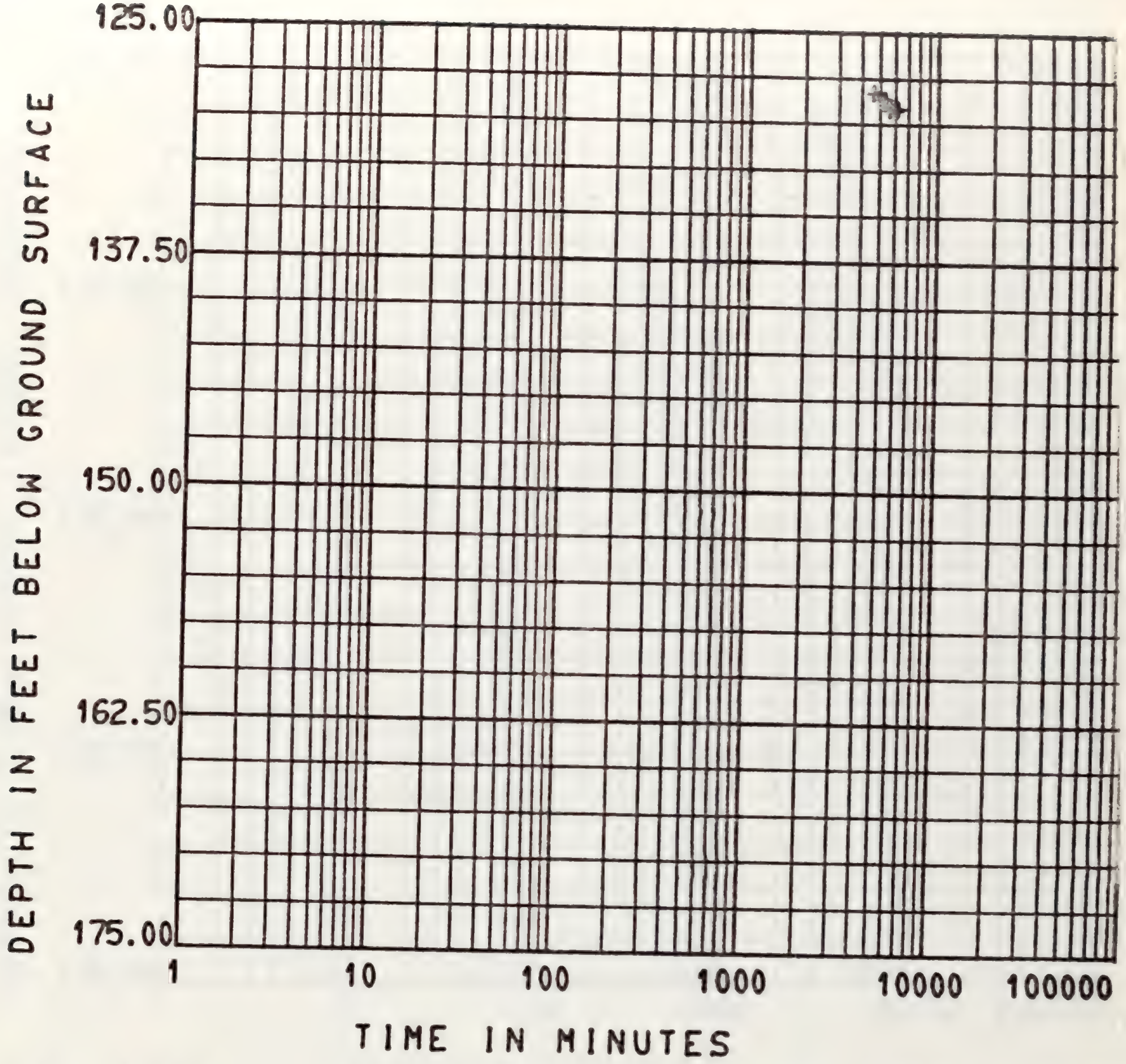
CE 709 CE 705A UPPR RECOVERY



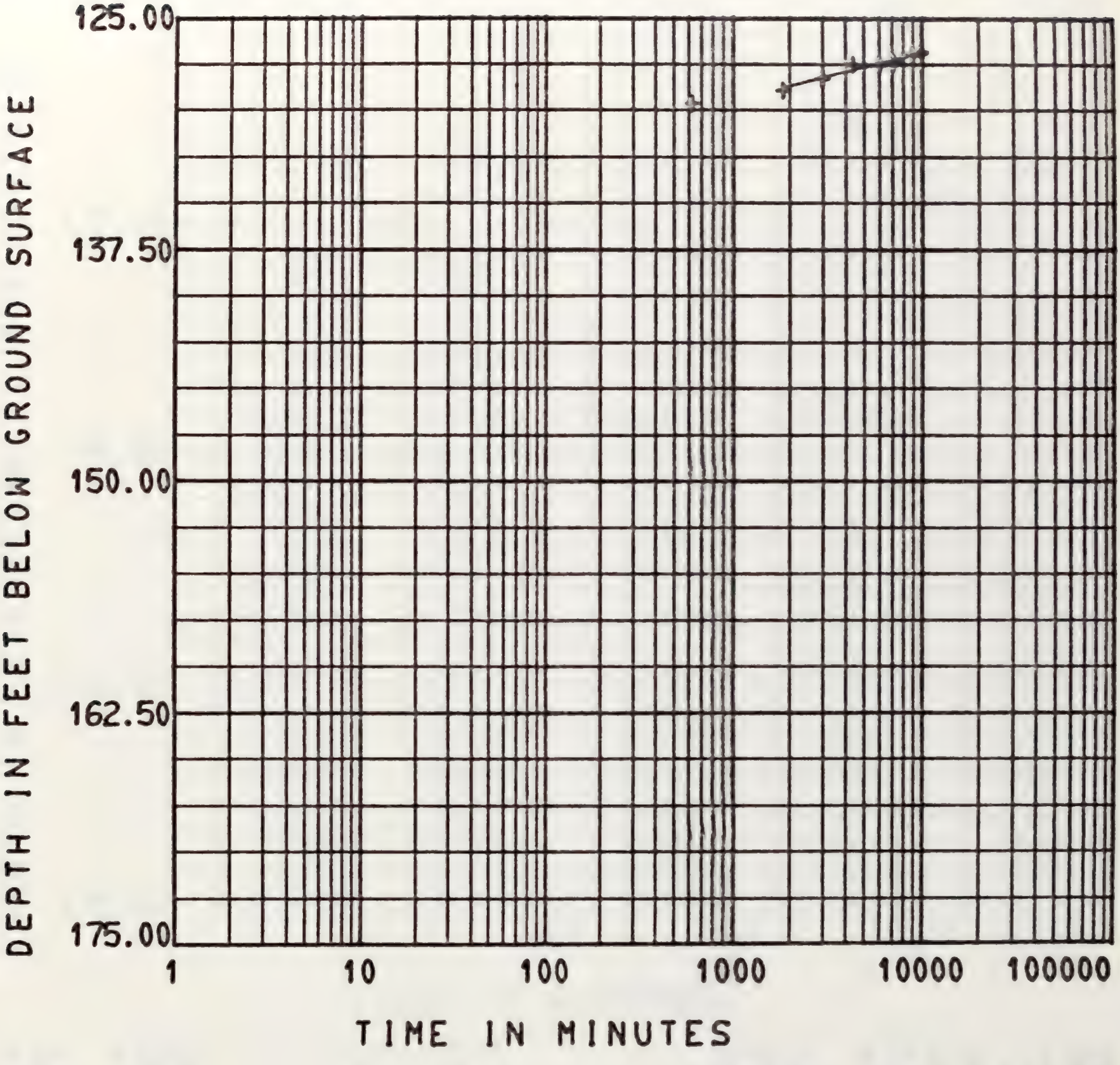
CE 709 GS-16 LOWR DRAWDOWN



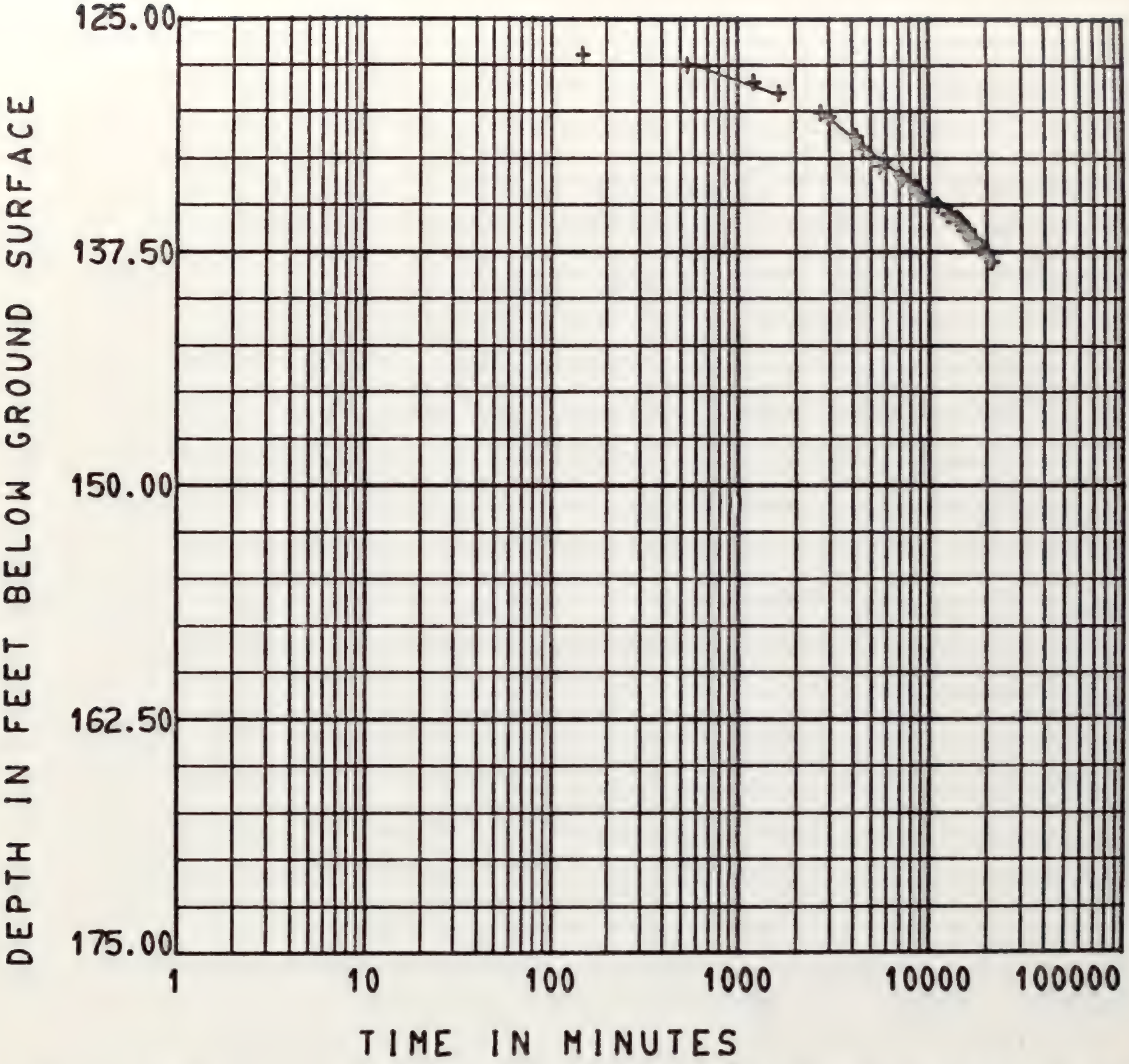
CE 709 GS-16 LOWR RECOVERY



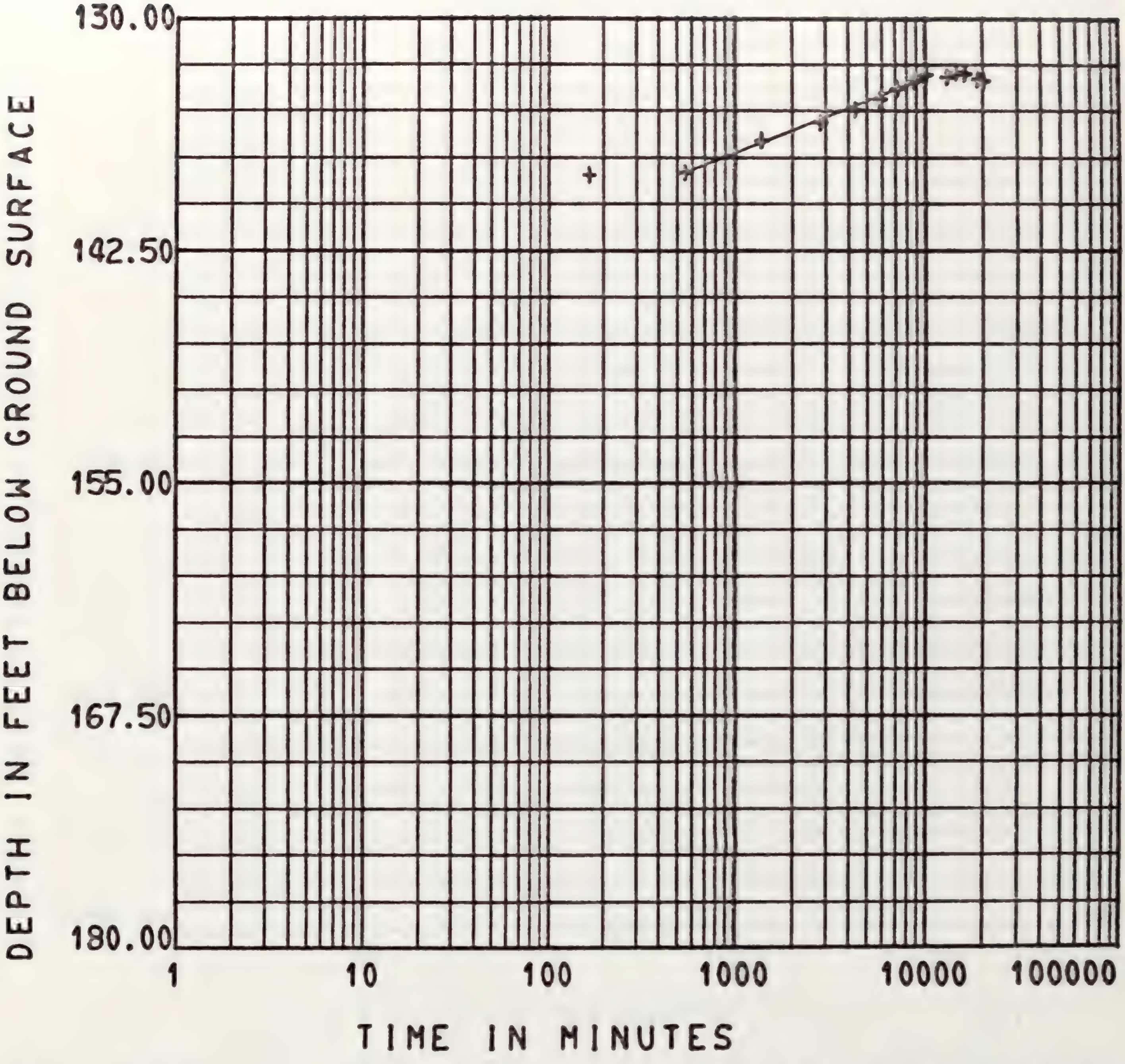
CE 709 GS-17 LOWR DRAWDOWN



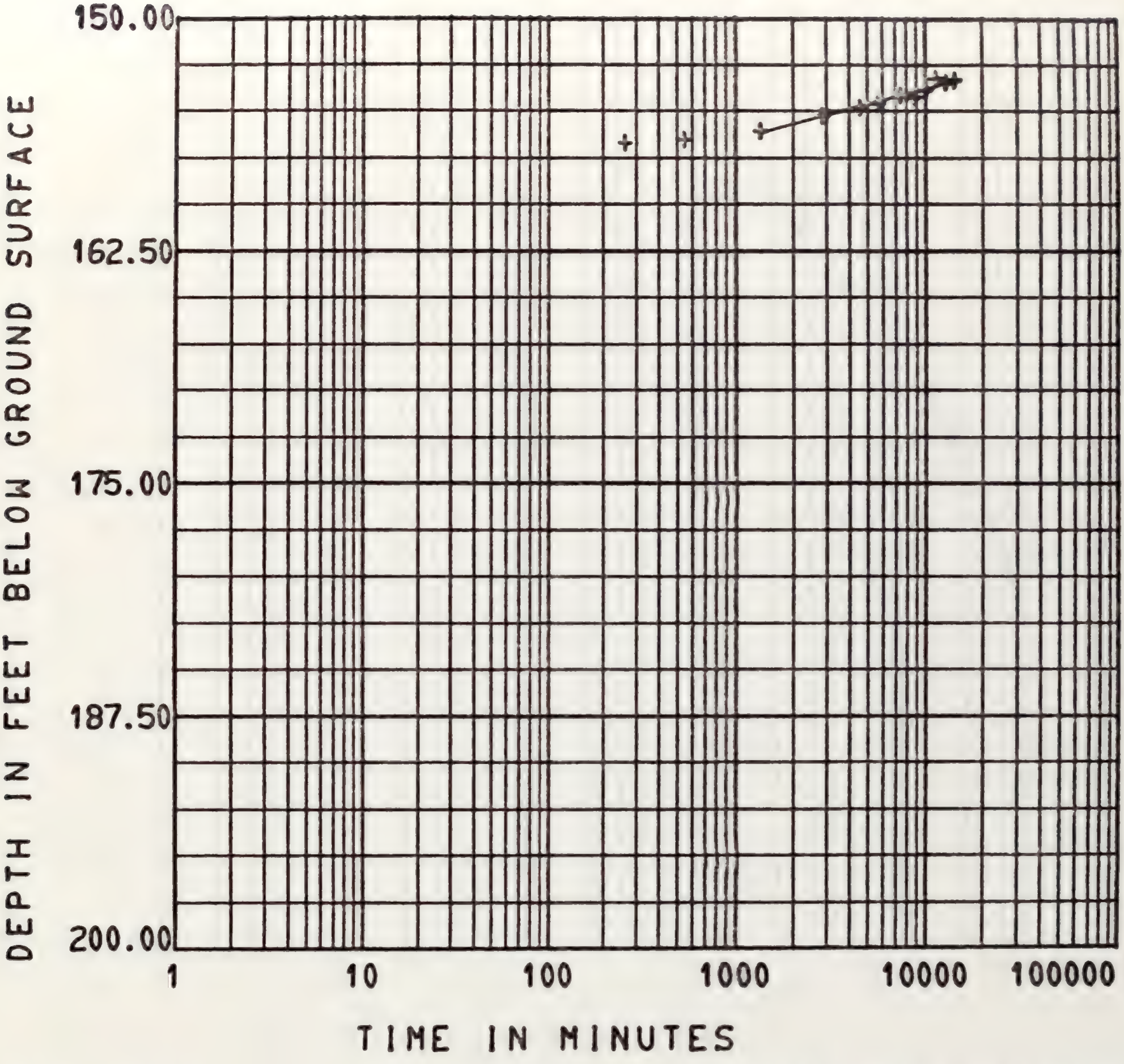
CE 709 GS-17 LOWR RECOVERY



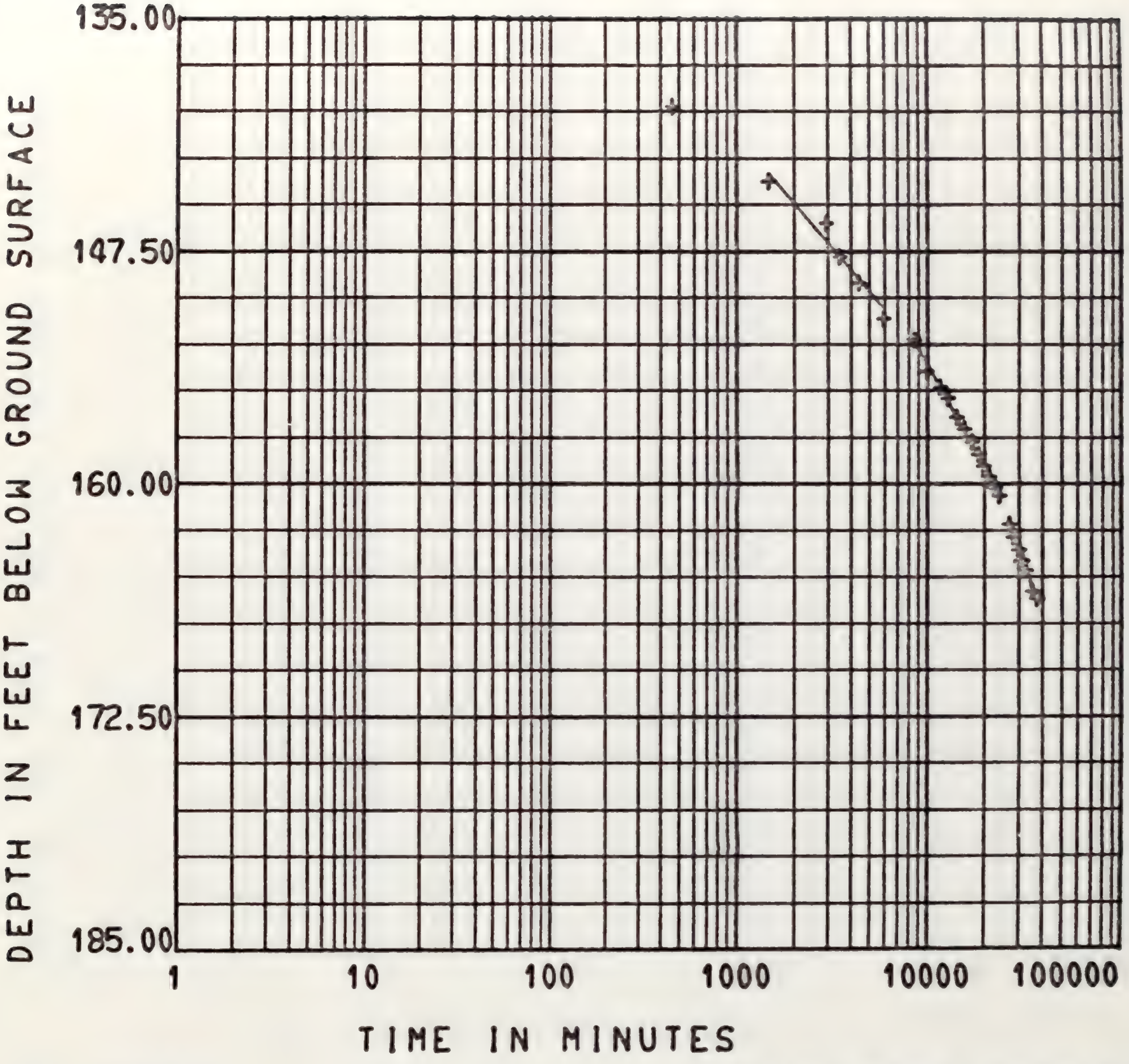
CE 709 GS-17 LOWR DRAWDOWN



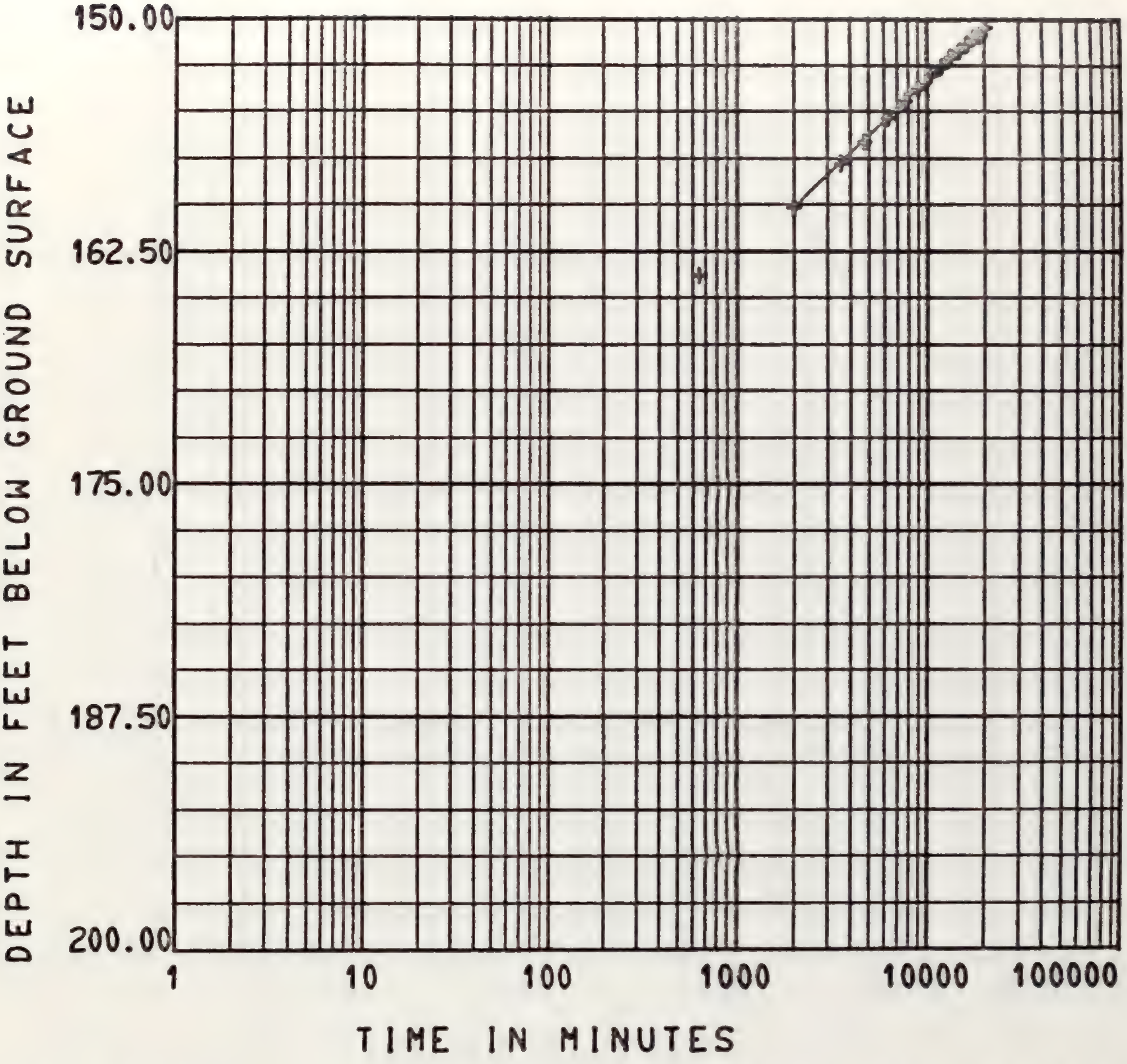
CE 709 GS-17 LOWR RECOVERY



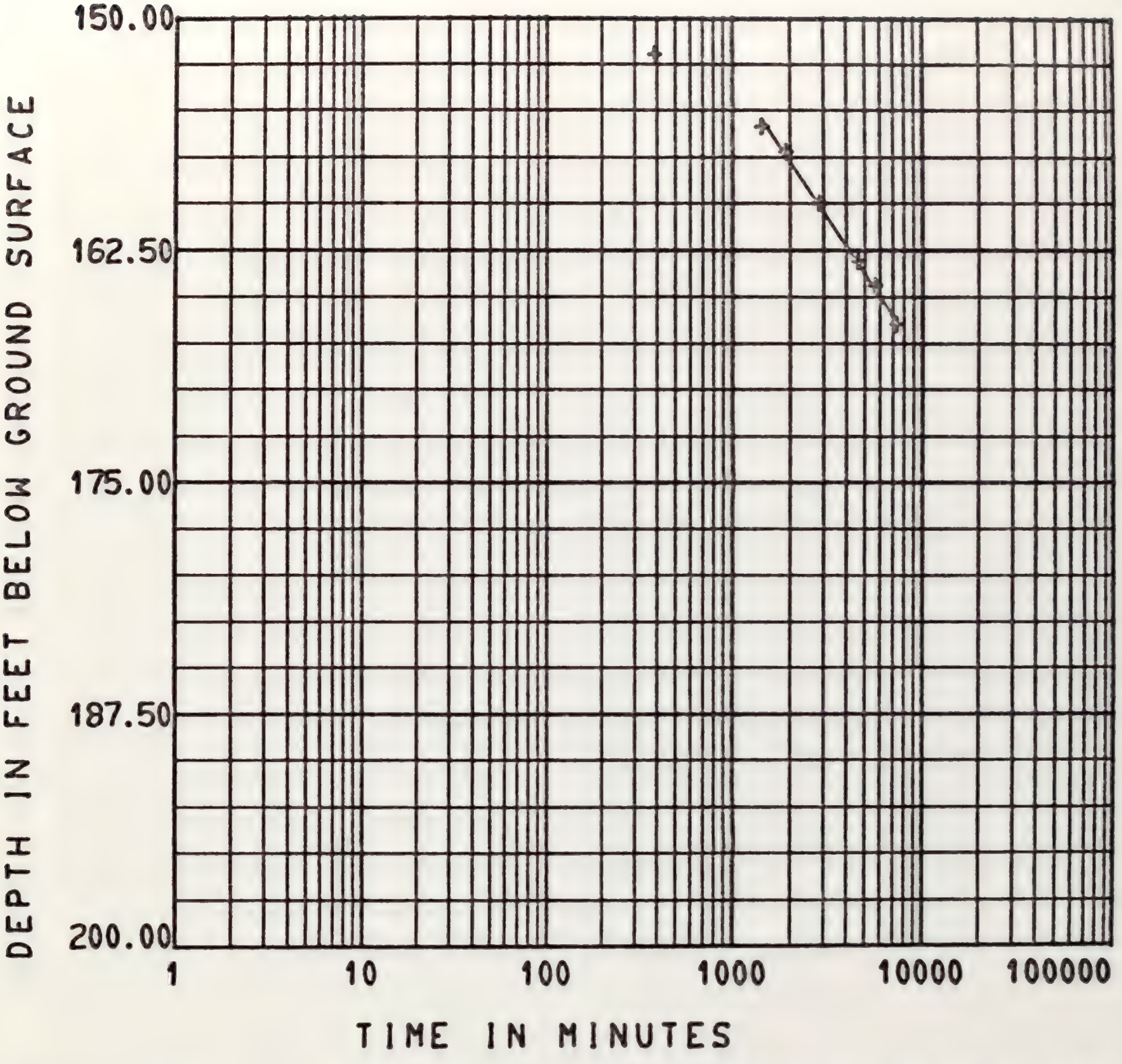
CE 709 GS-18 LOWR RECOVERY



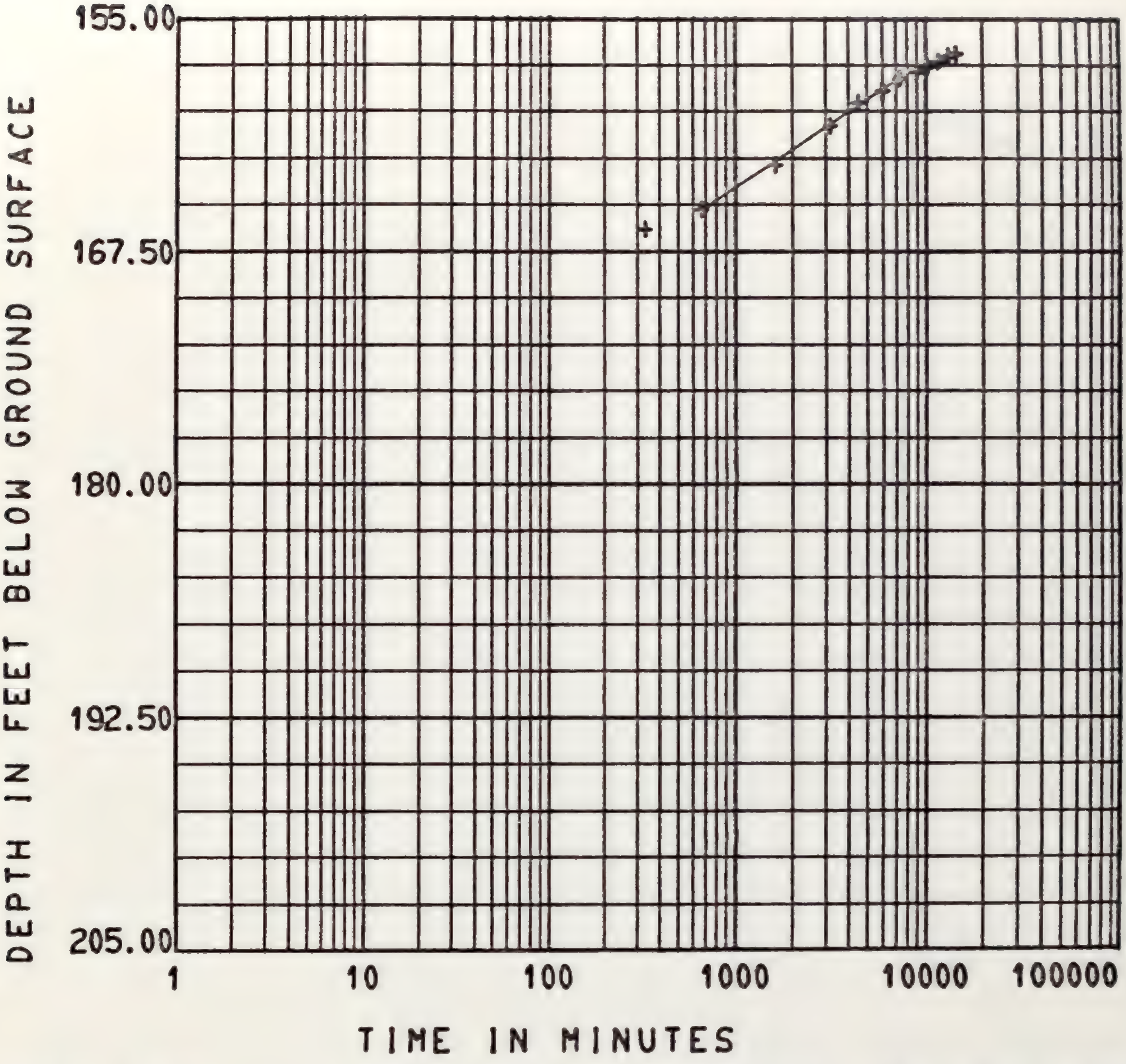
CE 709 GS-19 LOWR DRAWDOWN



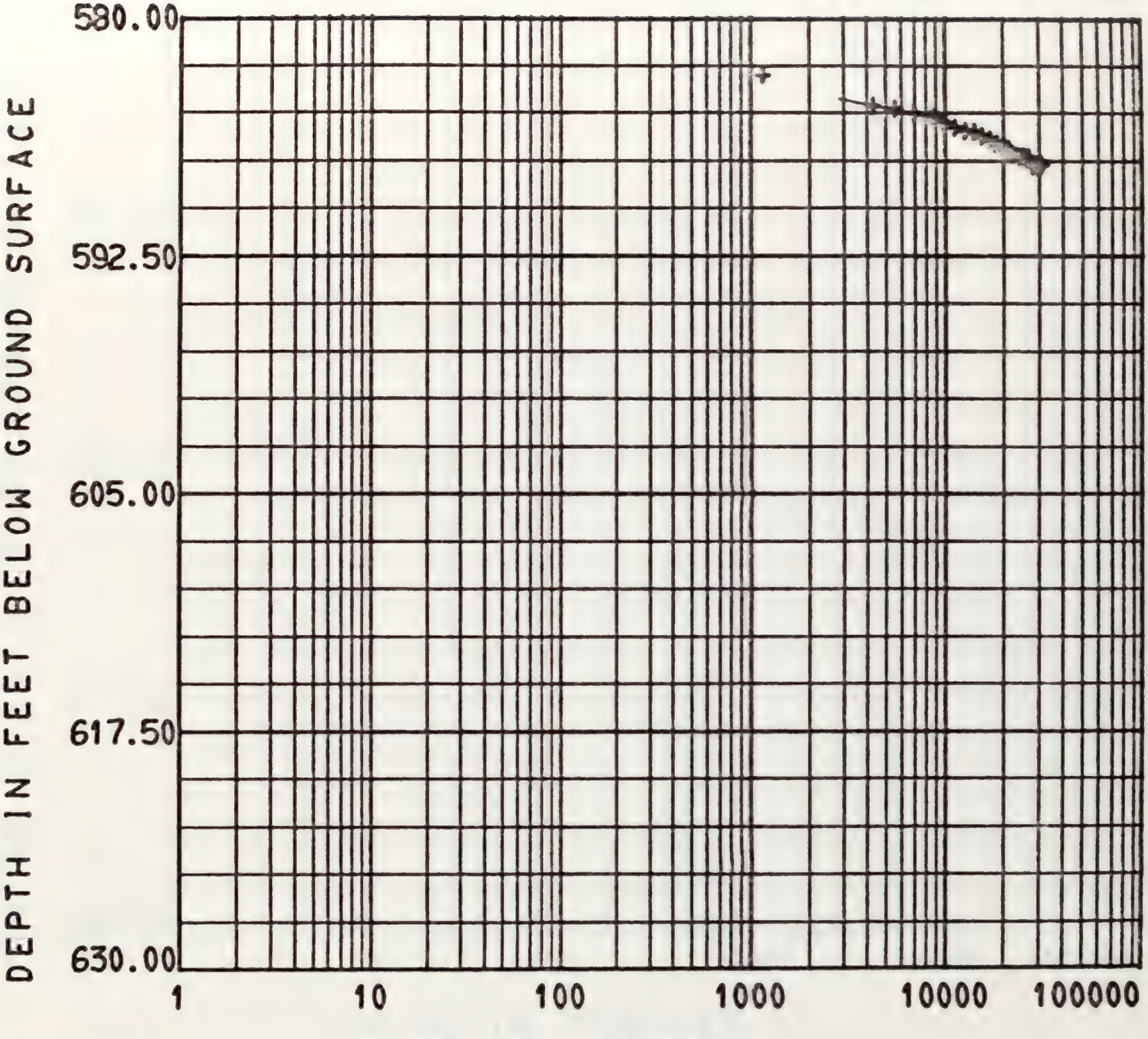
CE 709 GS-19 LOWR RECOVERY



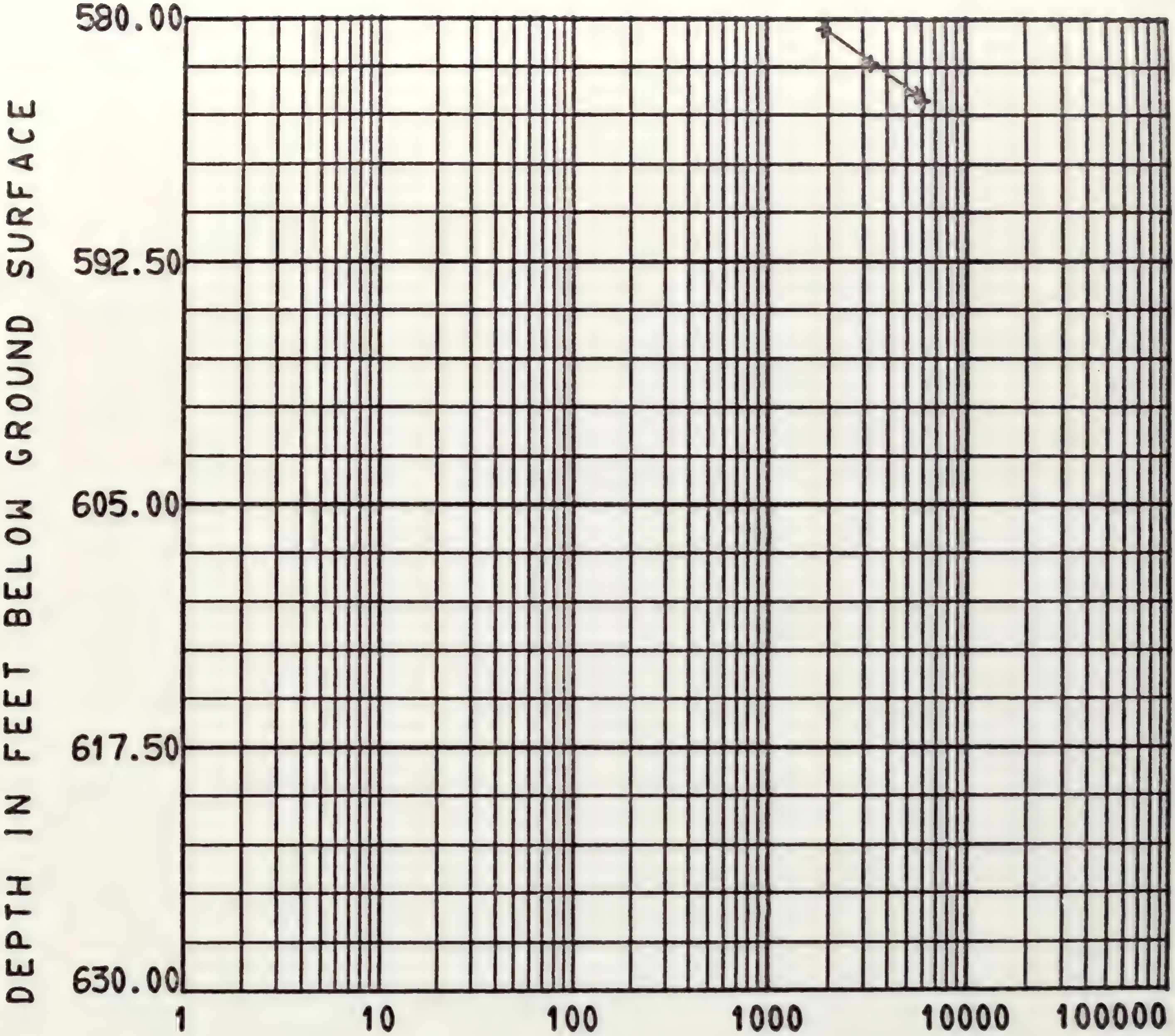
CE 709 GS-19 LOWR DRAWDOWN



CE 709 GS-19 LOWR RECOVERY

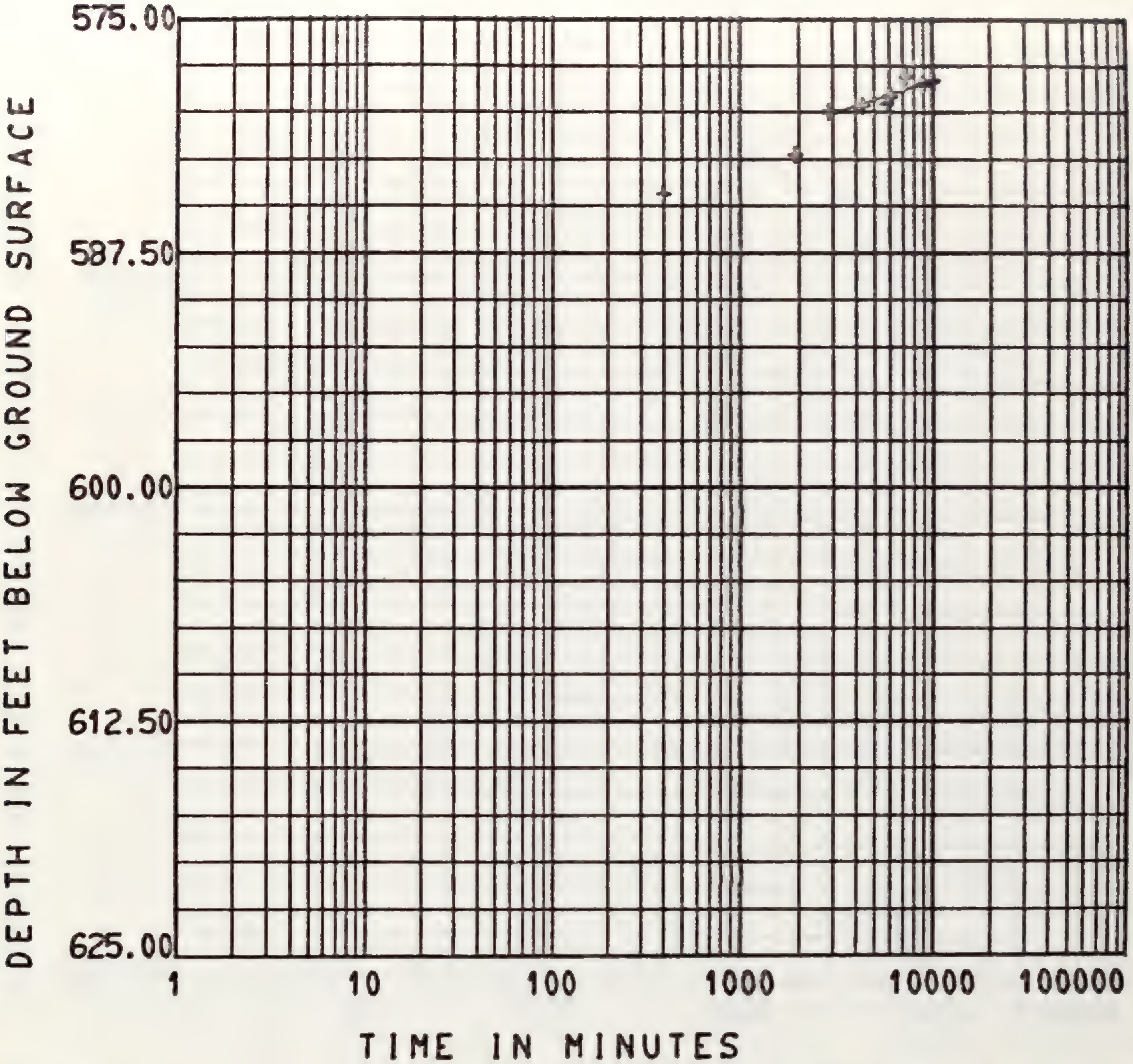


GS-1 GS-16 LOWR DRAWDOWN

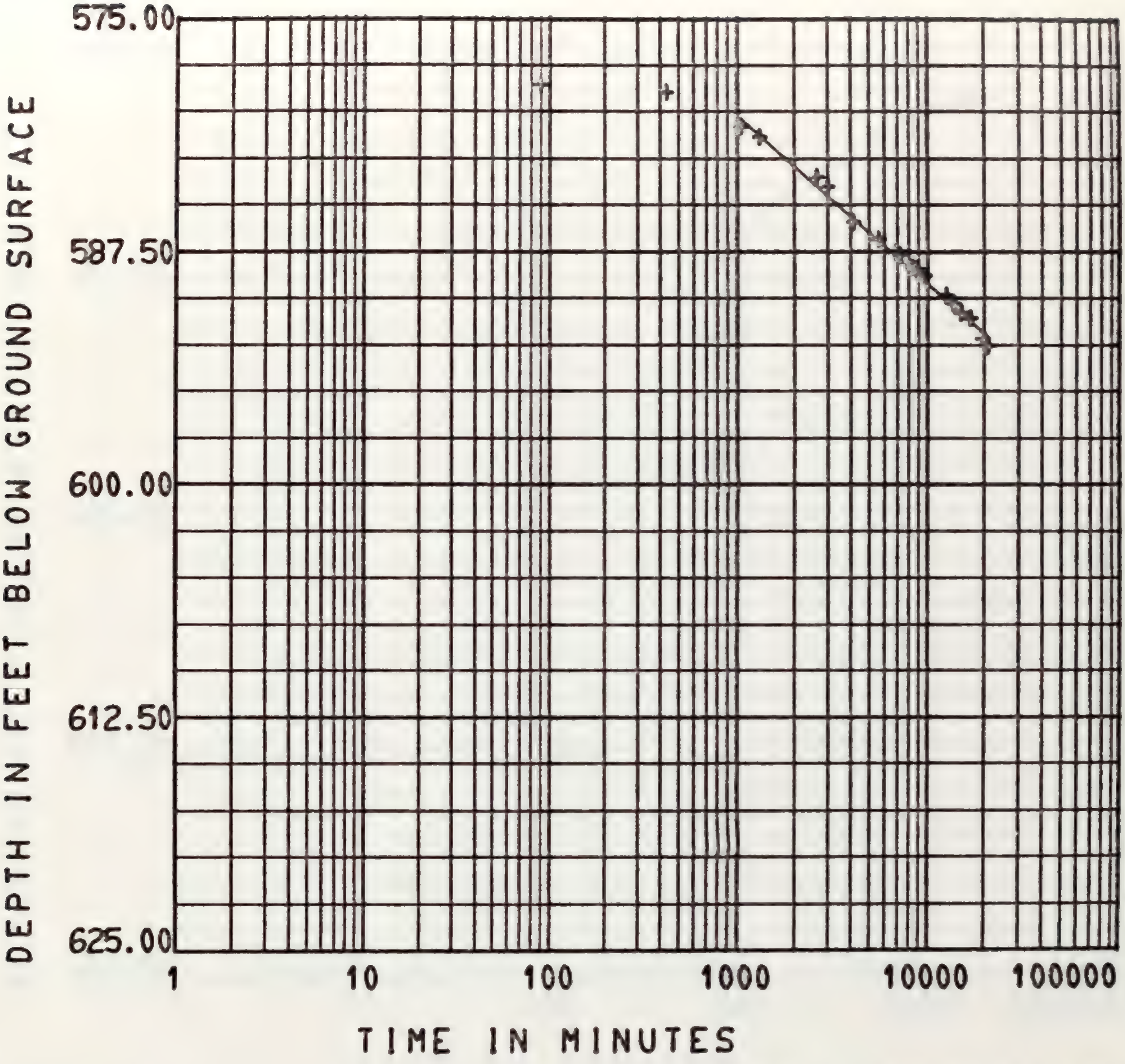


TIME IN MINUTES

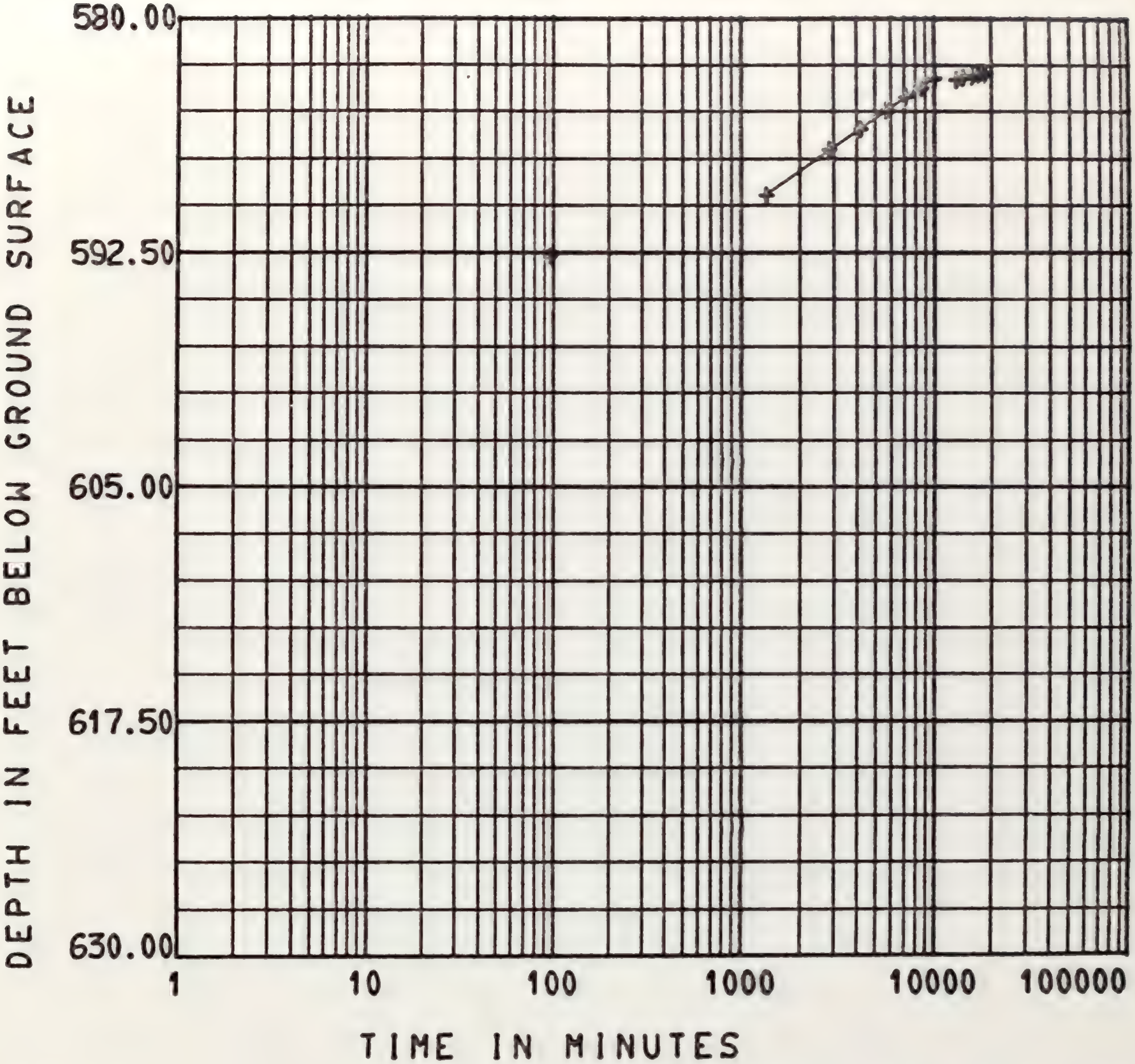
GS-1 GS-17 LOWR DRAWDOWN



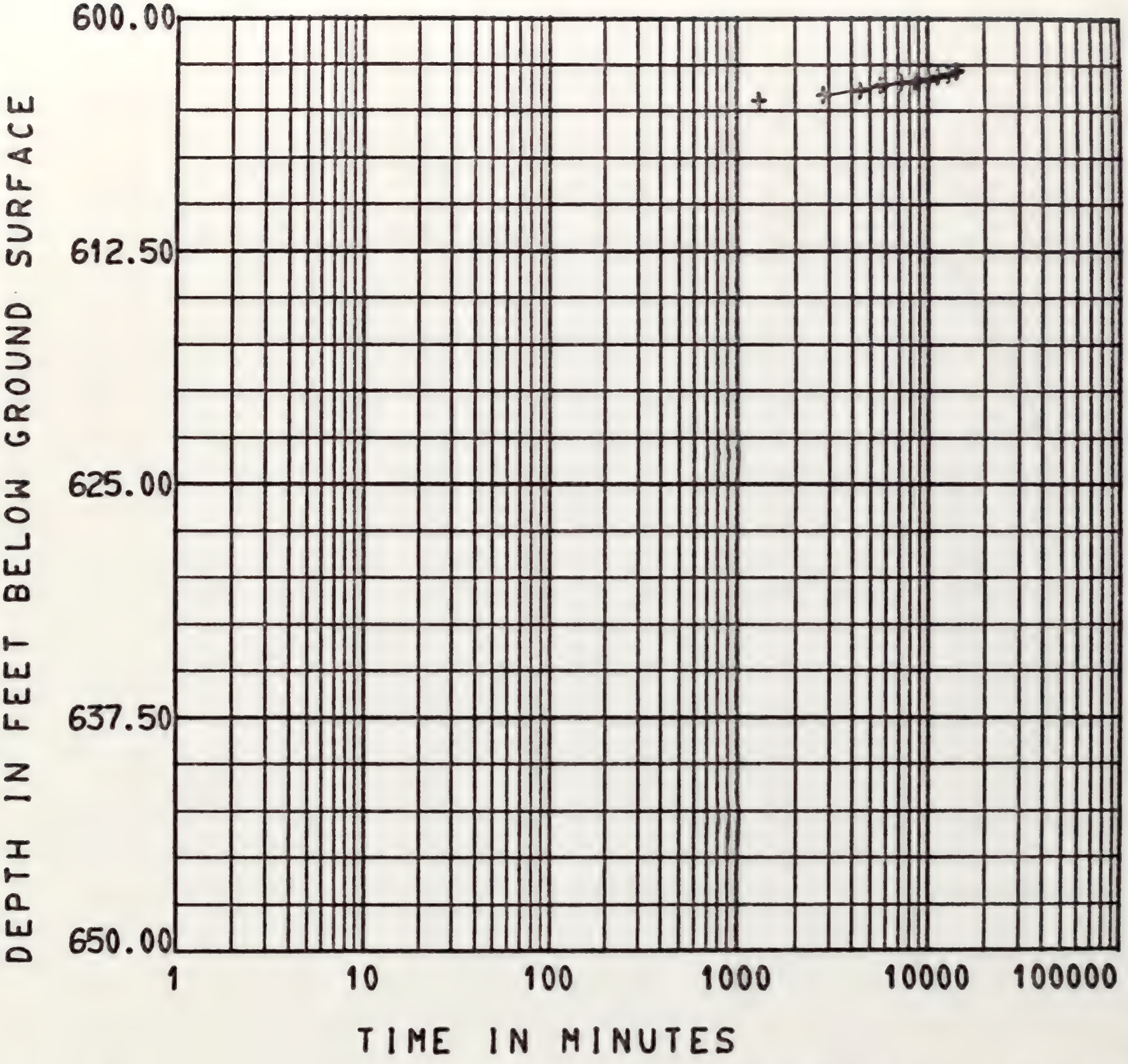
GS-1 GS-17 LOWR RECOVERY



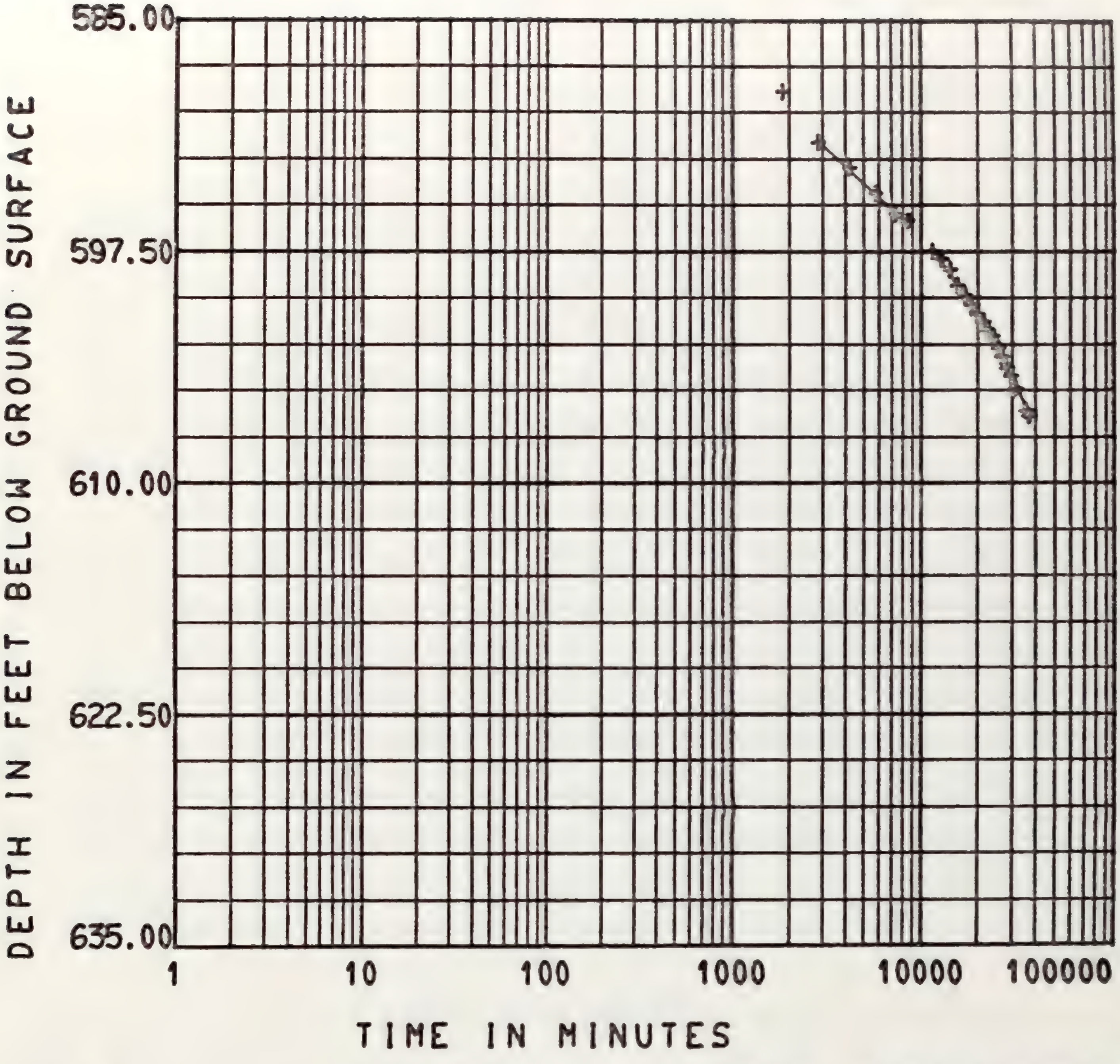
GS-1 GS-17 LOWR DRAWDOWN



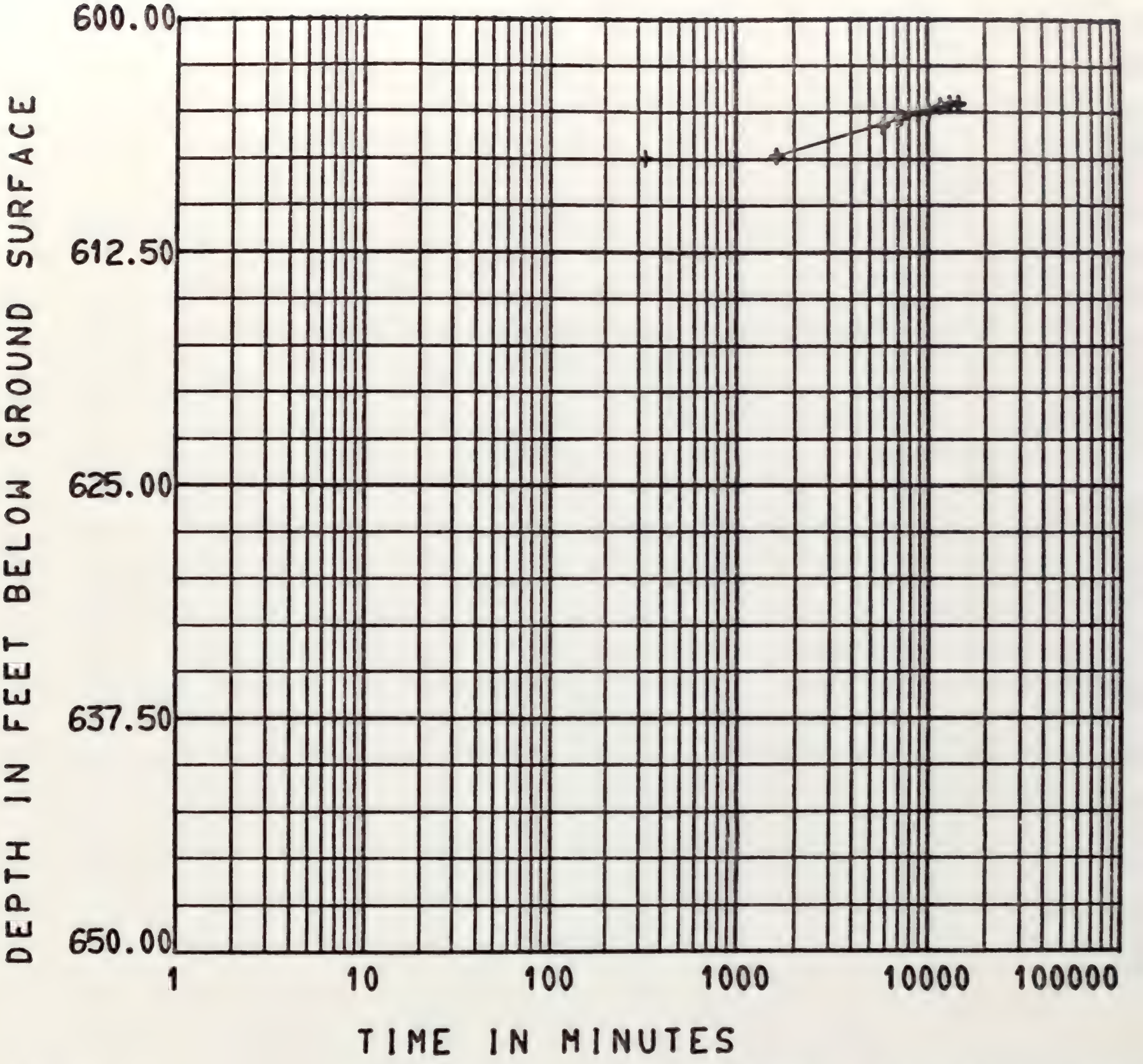
GS-1 GS-17 LOWR RECOVERY



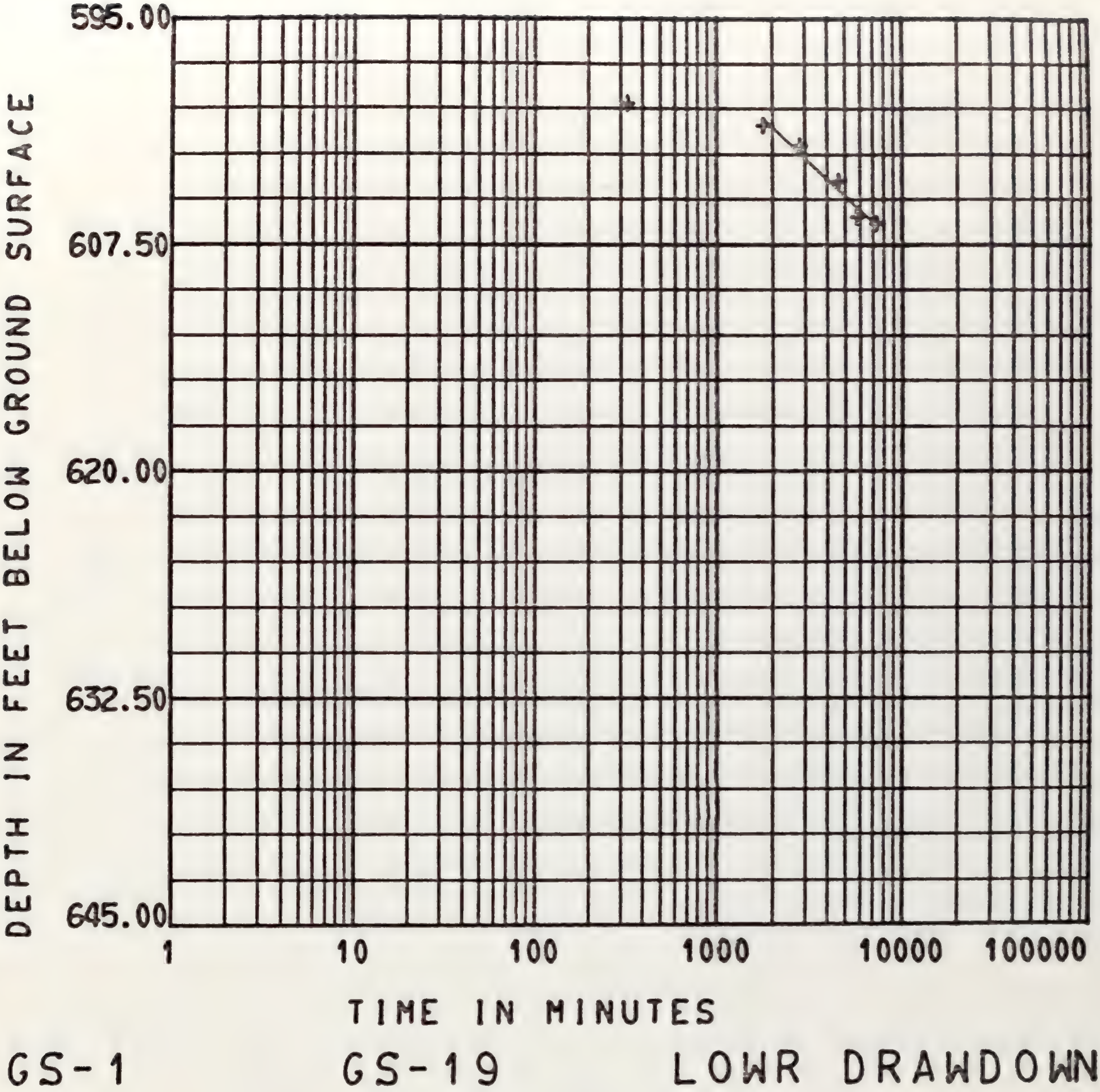
GS-1 GS-18 LOWR RECOVERY



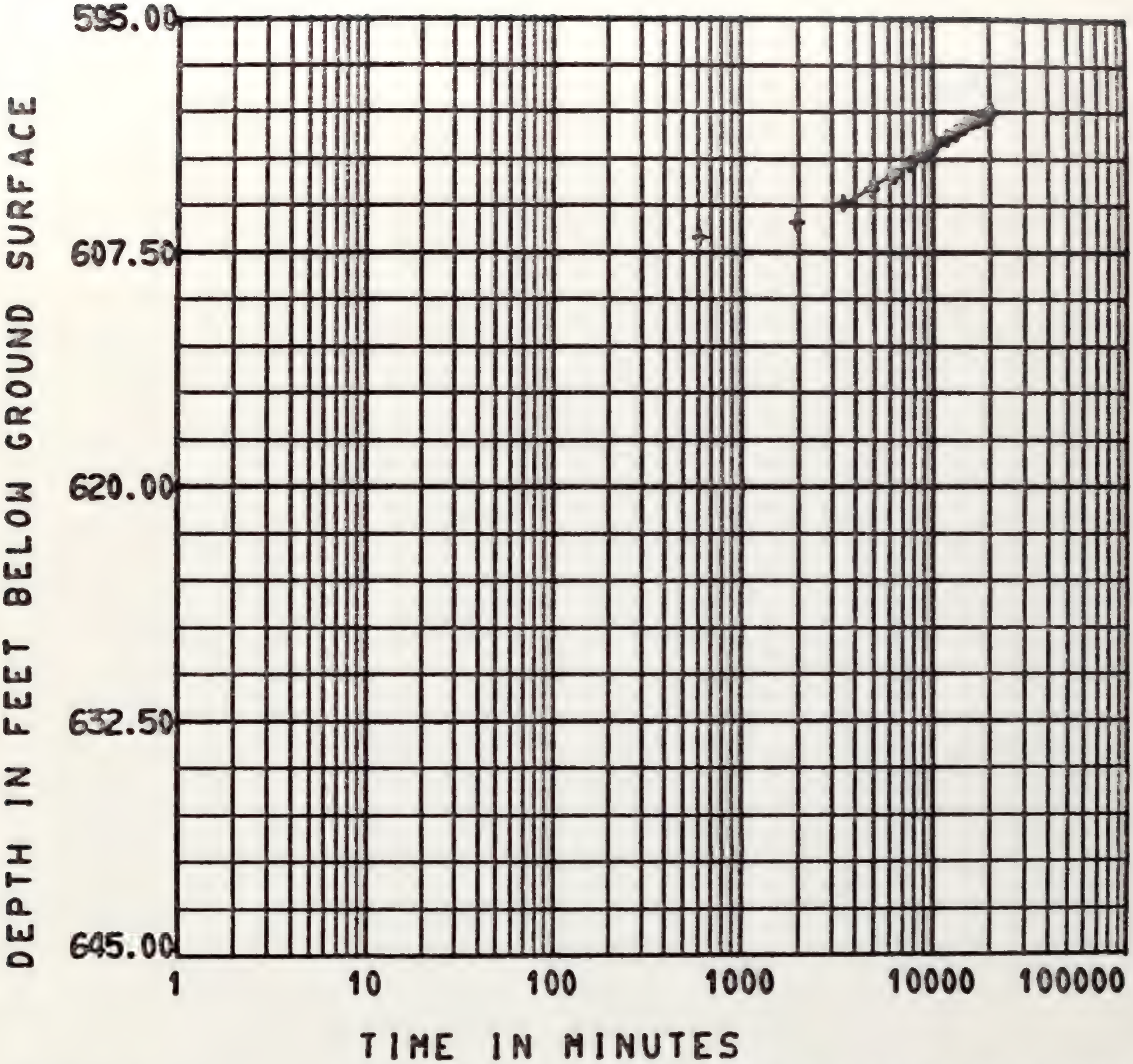
GS-1 GS-19 LOWR DRAWDOWN



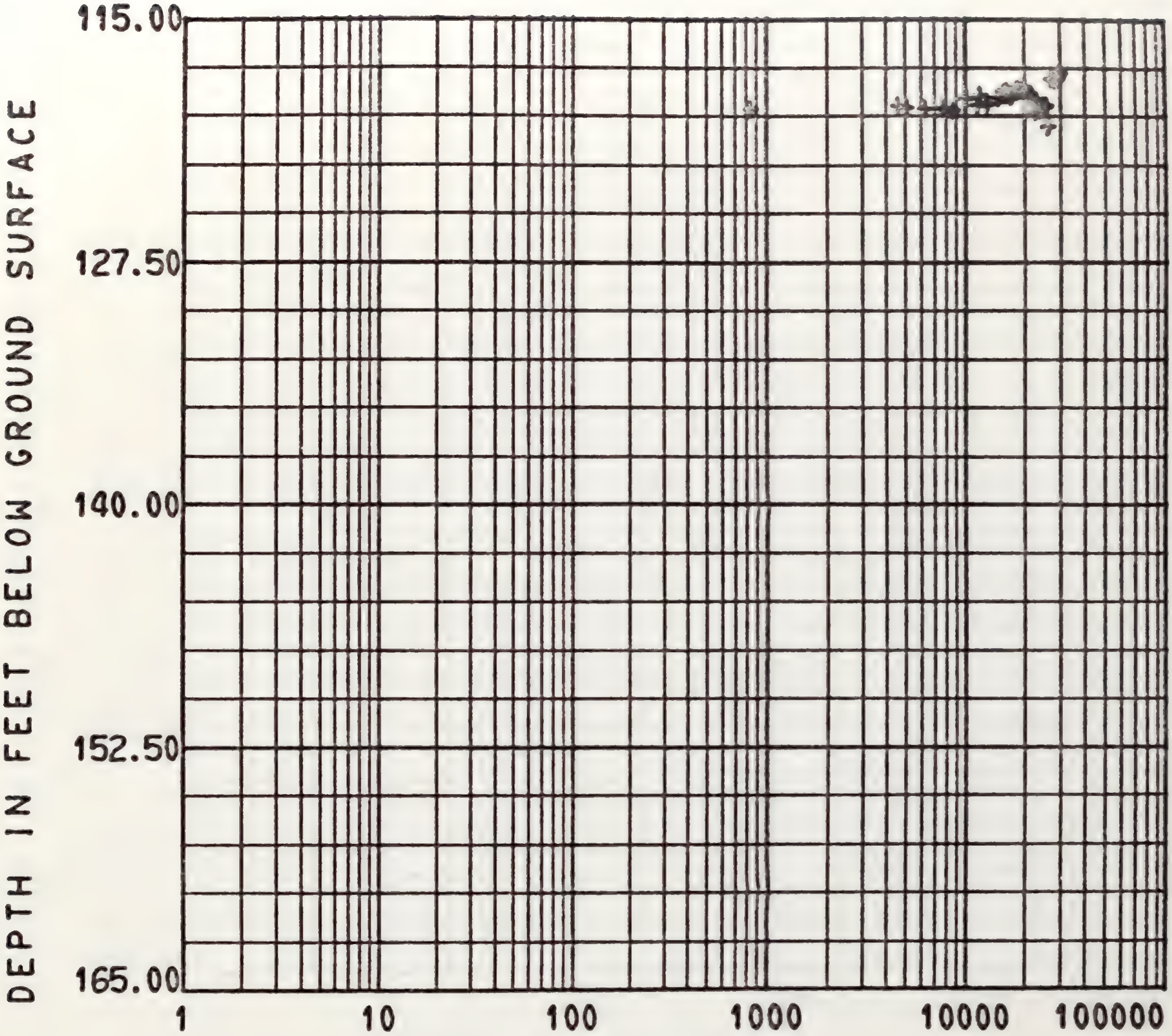
GS-1 GS-19 LOWR RECOVERY



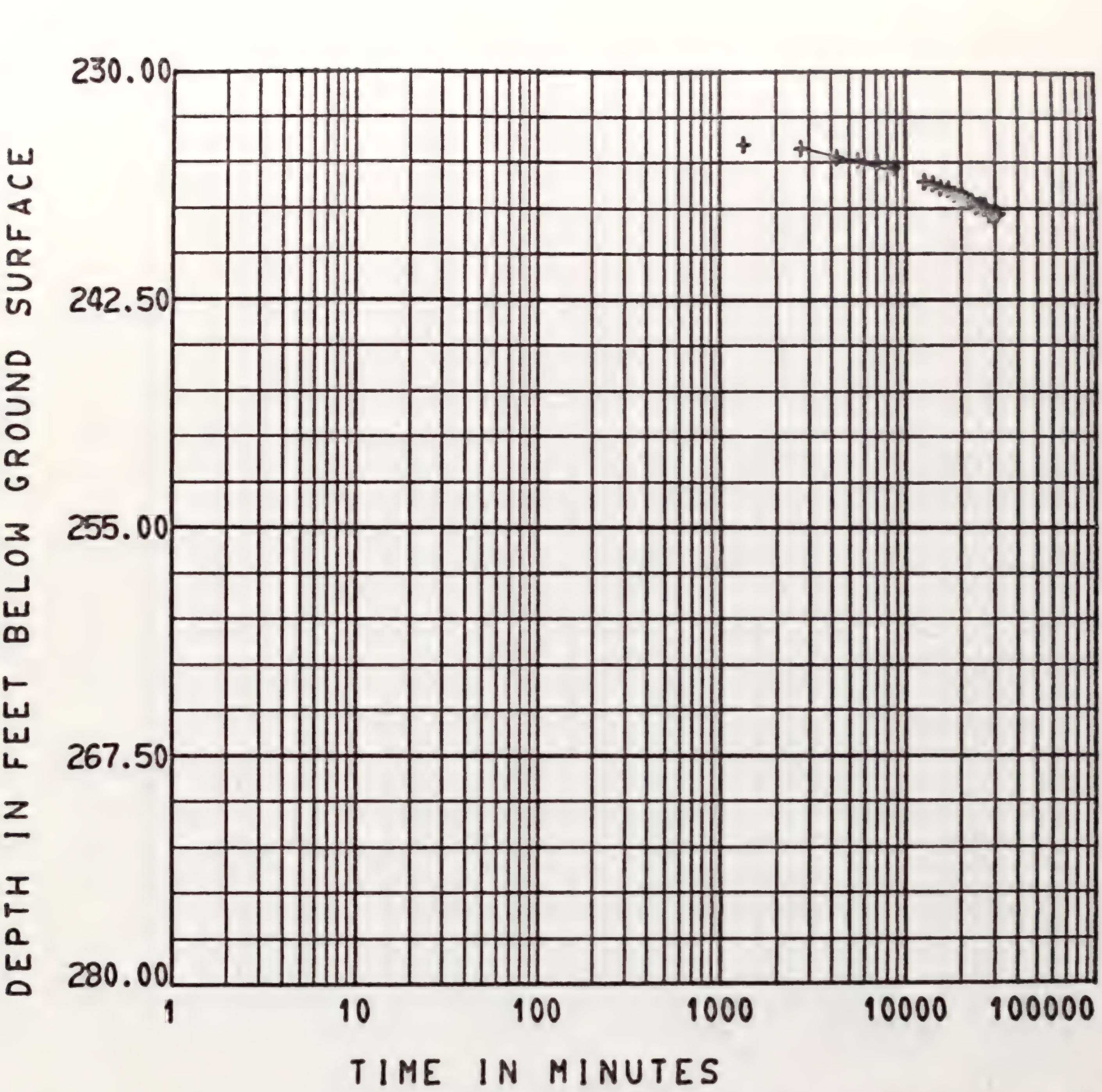
GS-1 GS-19 LOWR DRAWDOWN



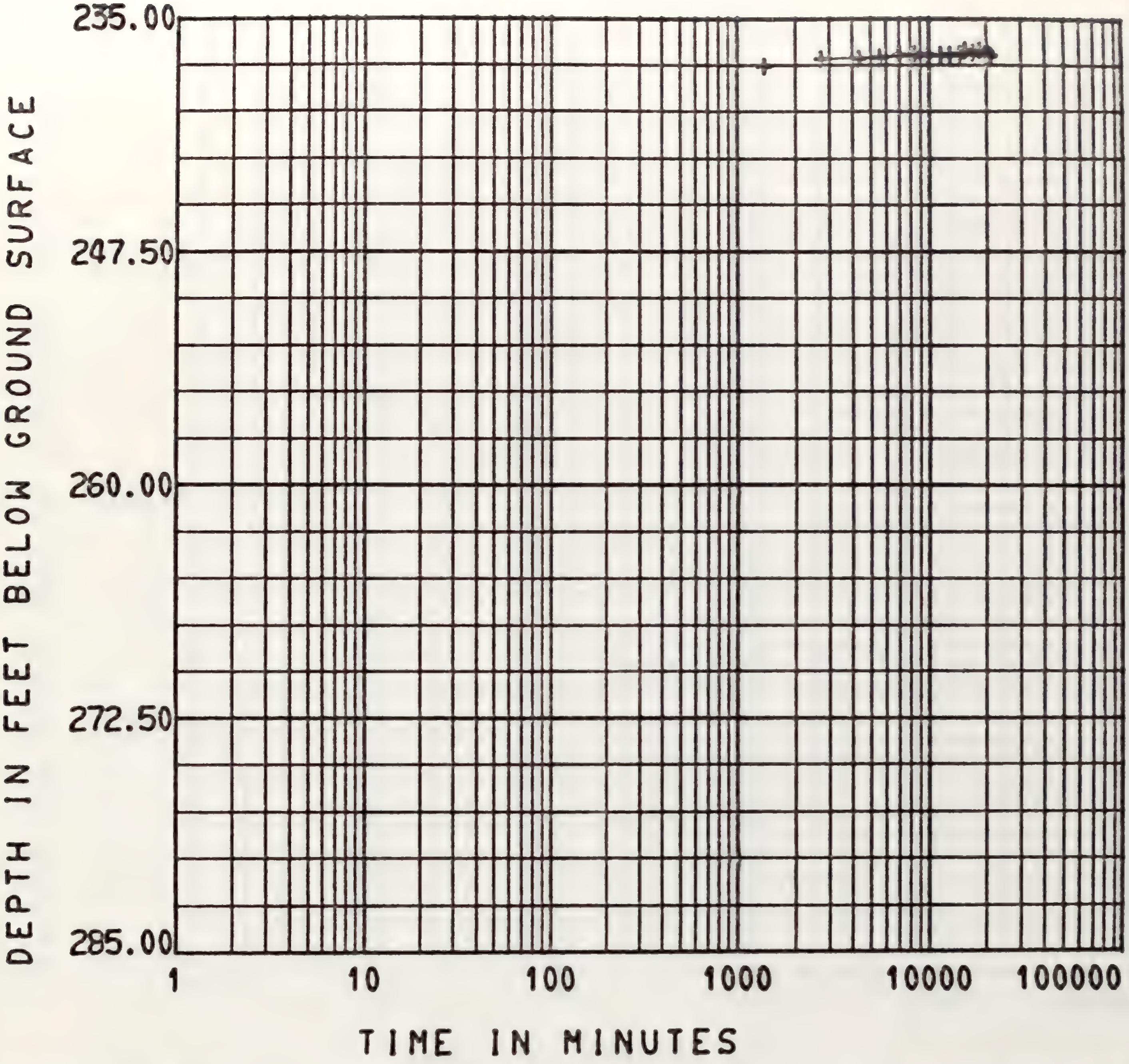
GS-1 GS-19 LOWR RECOVERY



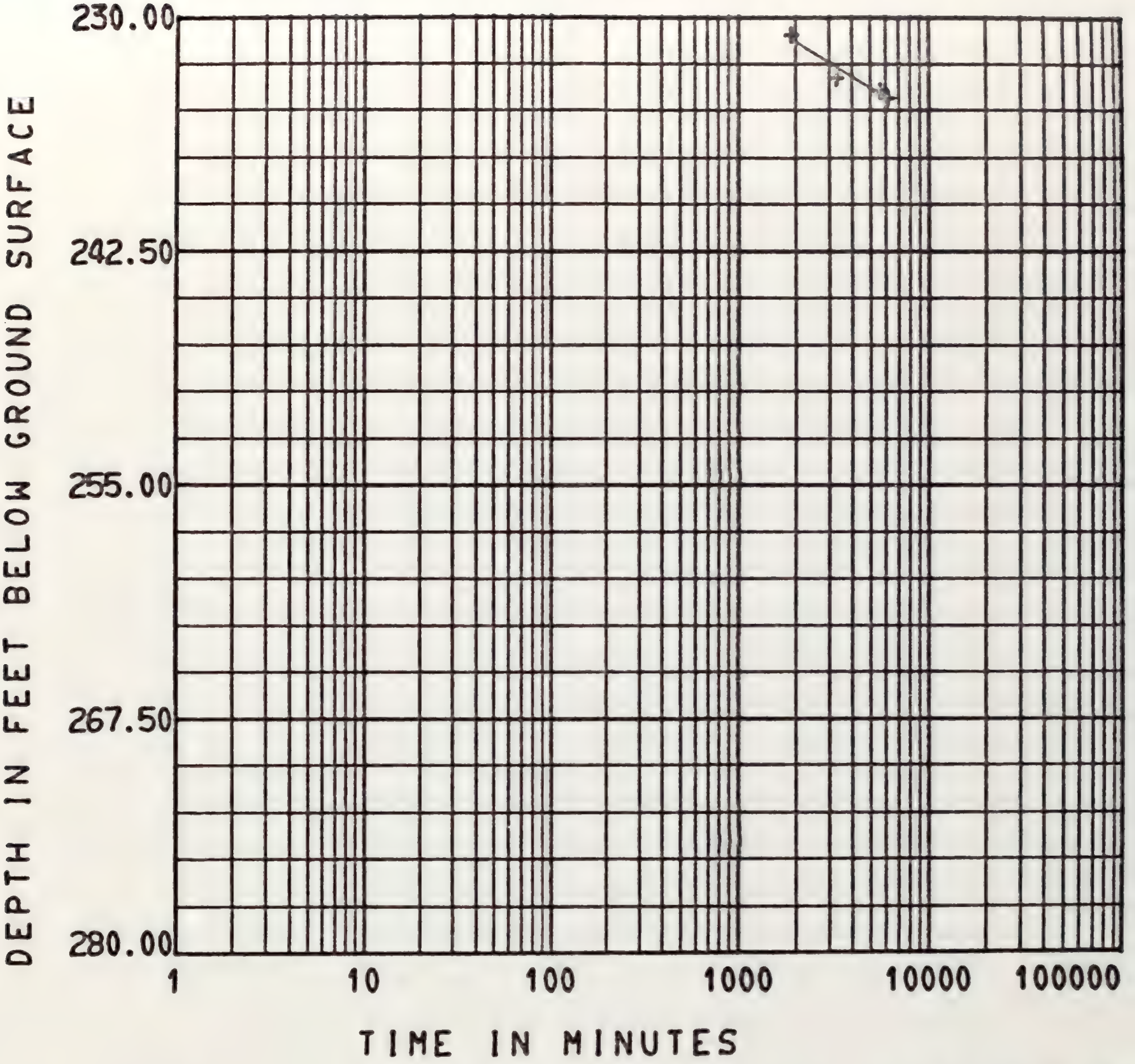
GS-2-3 TO-3 UPPR DRAWDOWN



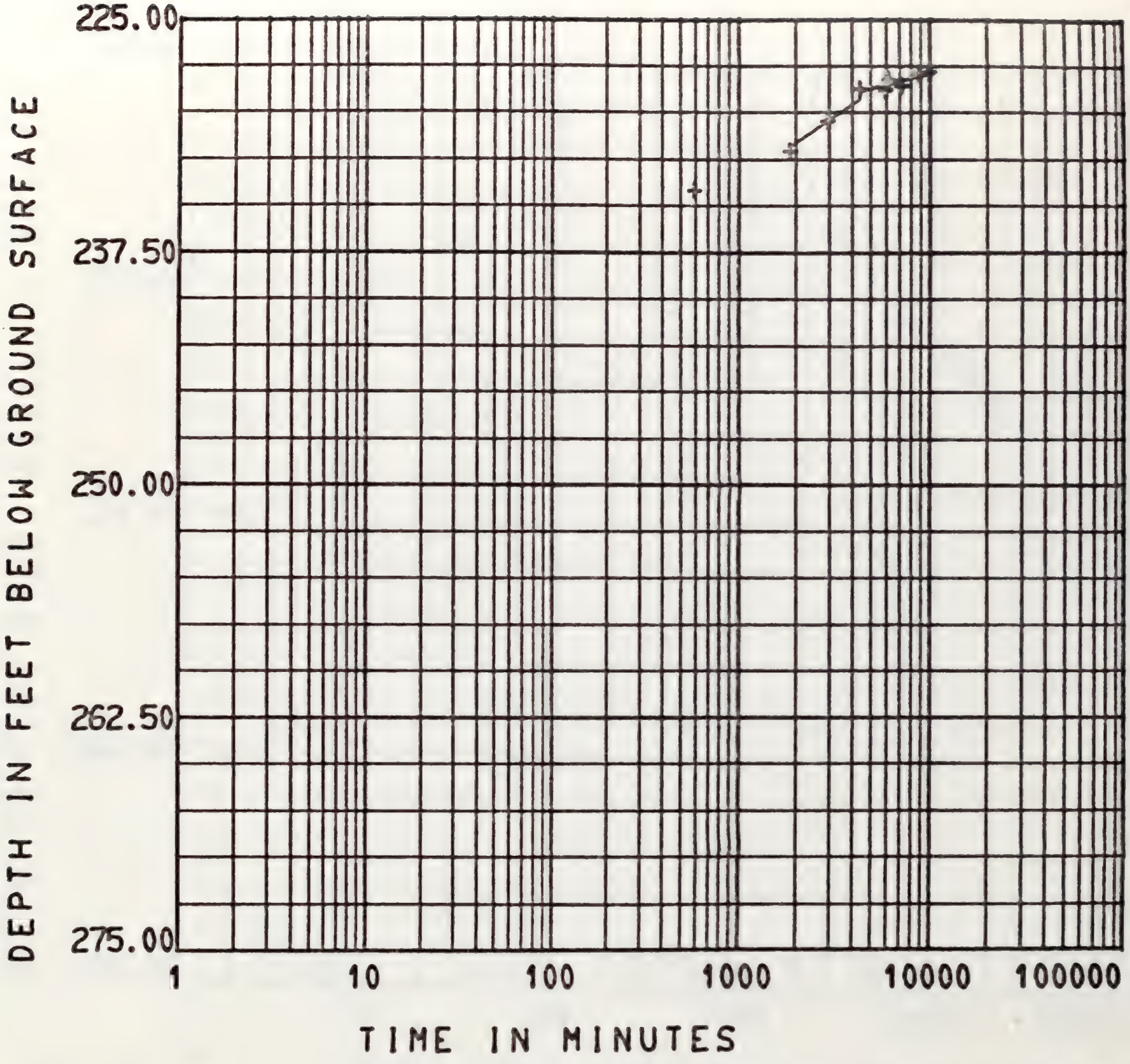
GS-2-3 GS-16 LOWR DRAWDOWN



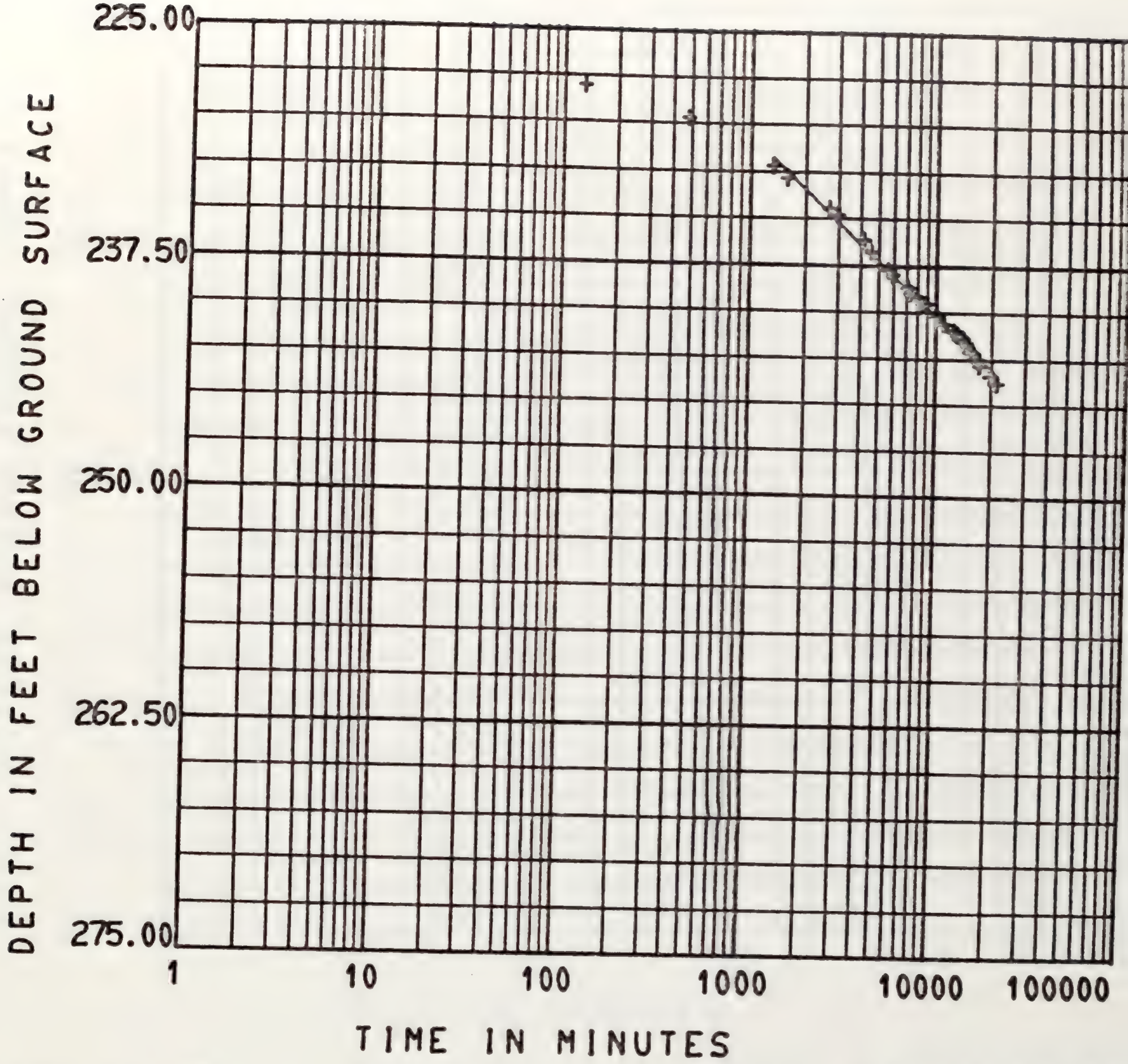
GS-2-3 GS-16 LOWR RECOVERY



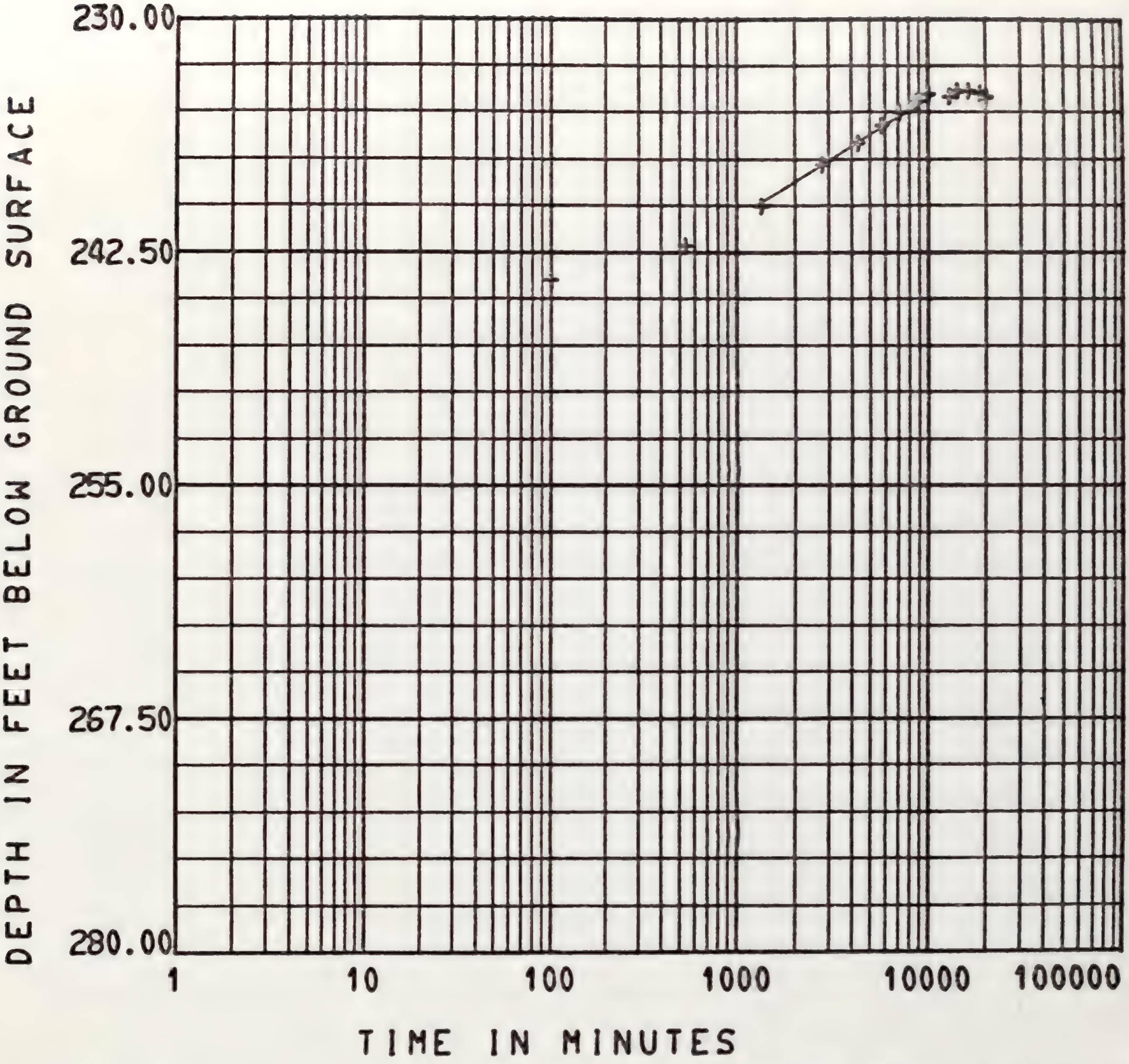
GS-2-3 GS-17 LOWR DRAWDOWN



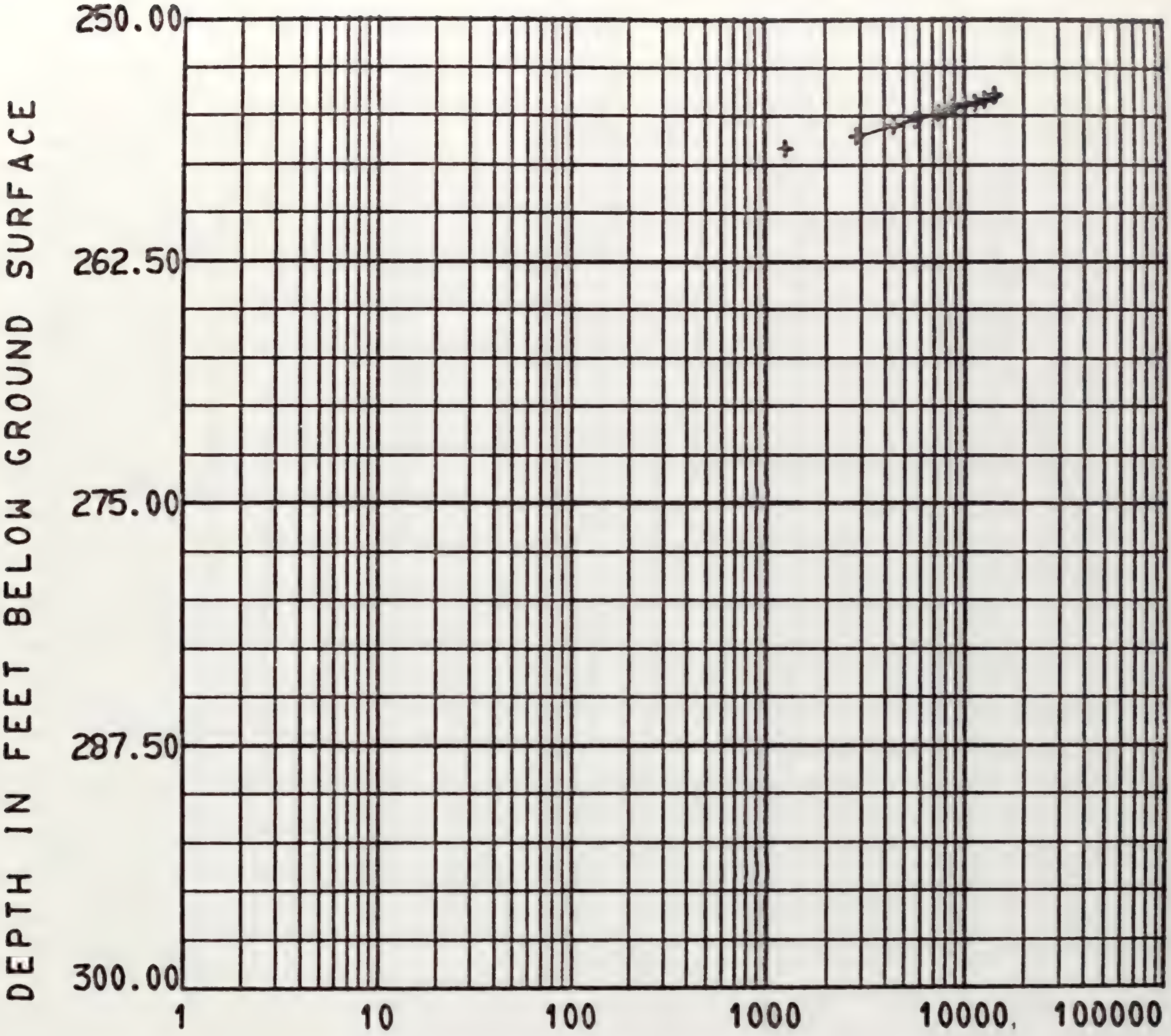
GS-2-3 GS-17 LOWR RECOVERY



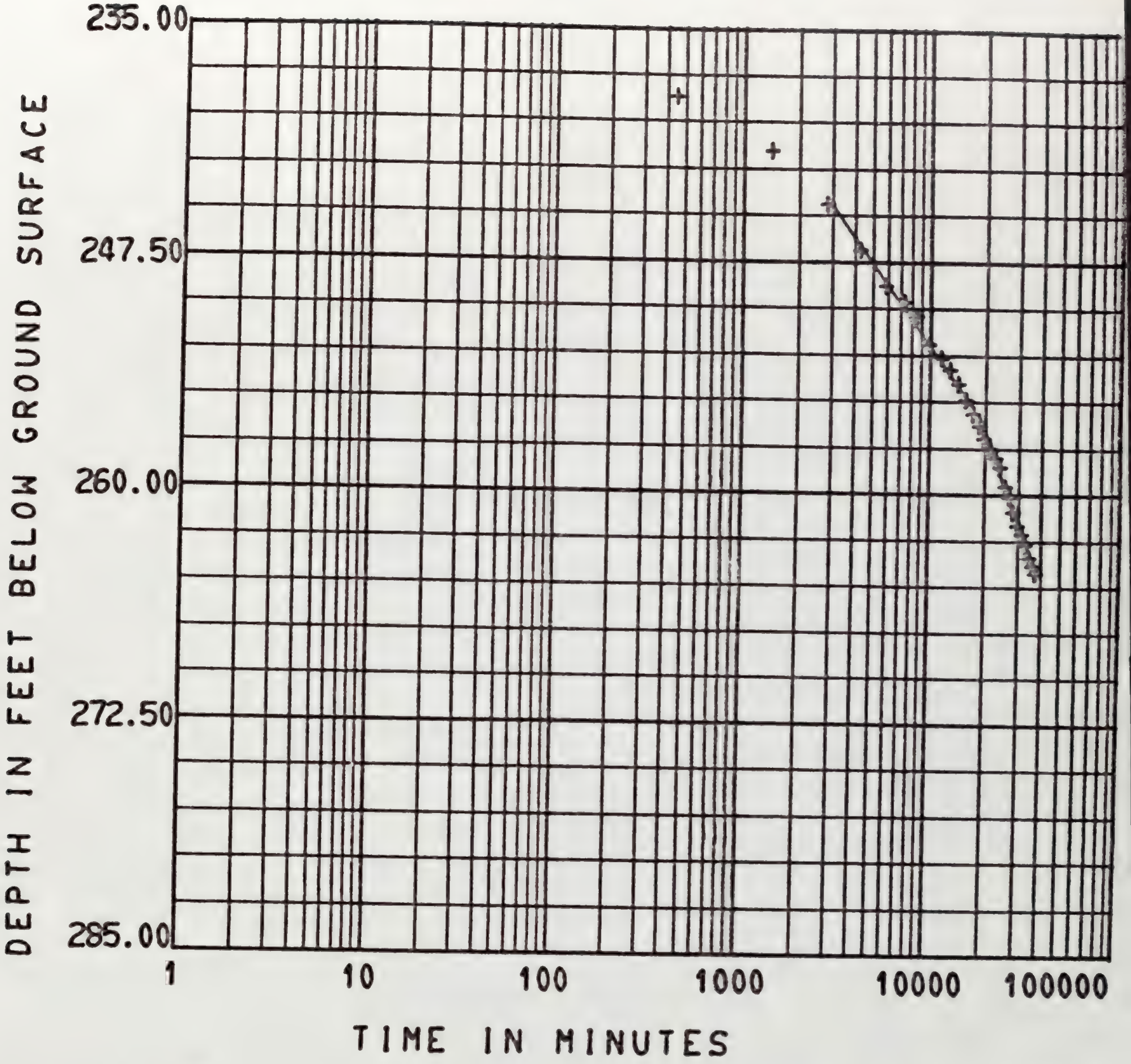
GS-2-3 GS-17 LOWR DRAWDOWN



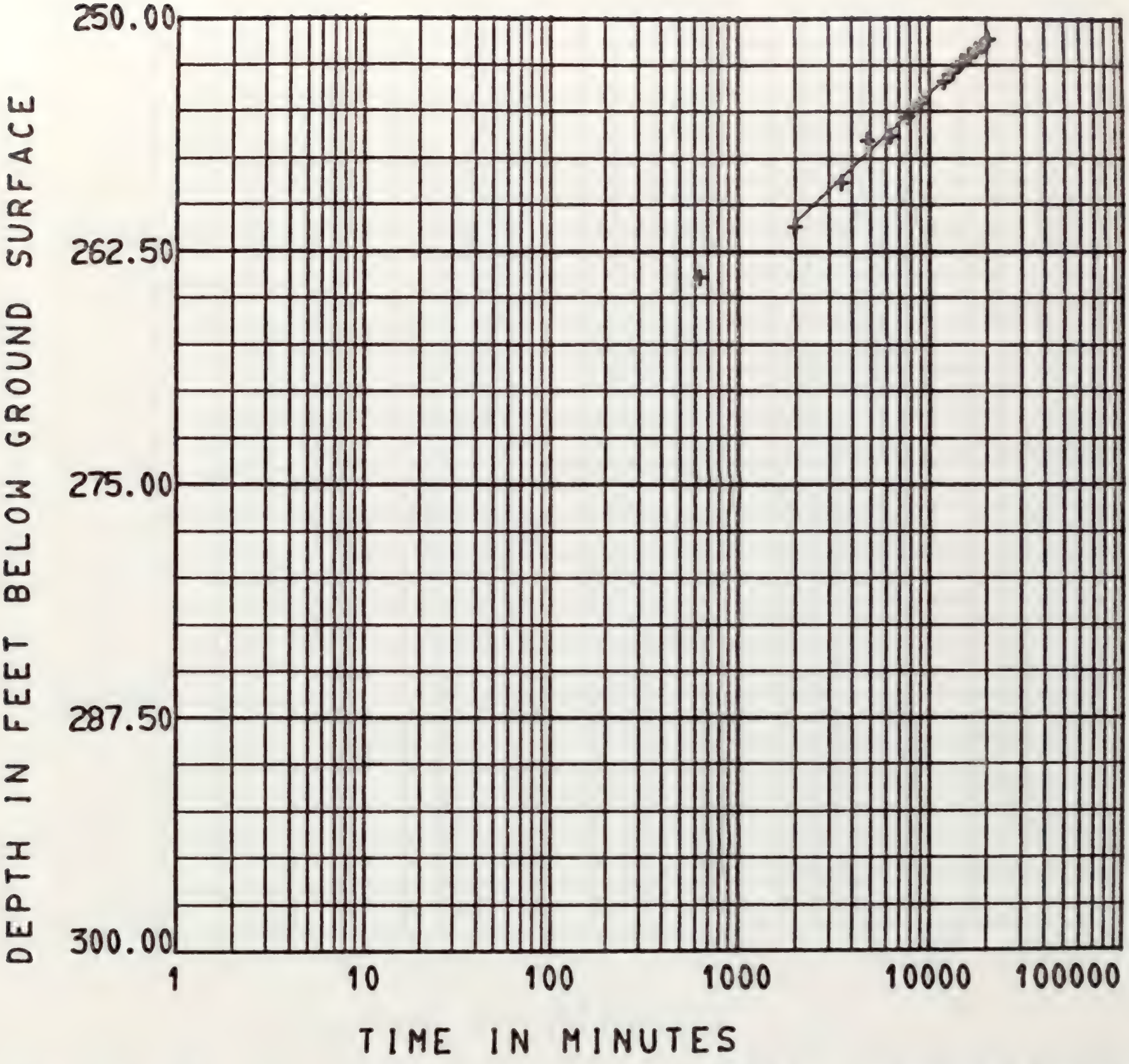
GS-2-3 GS-17 LOWR RECOVERY



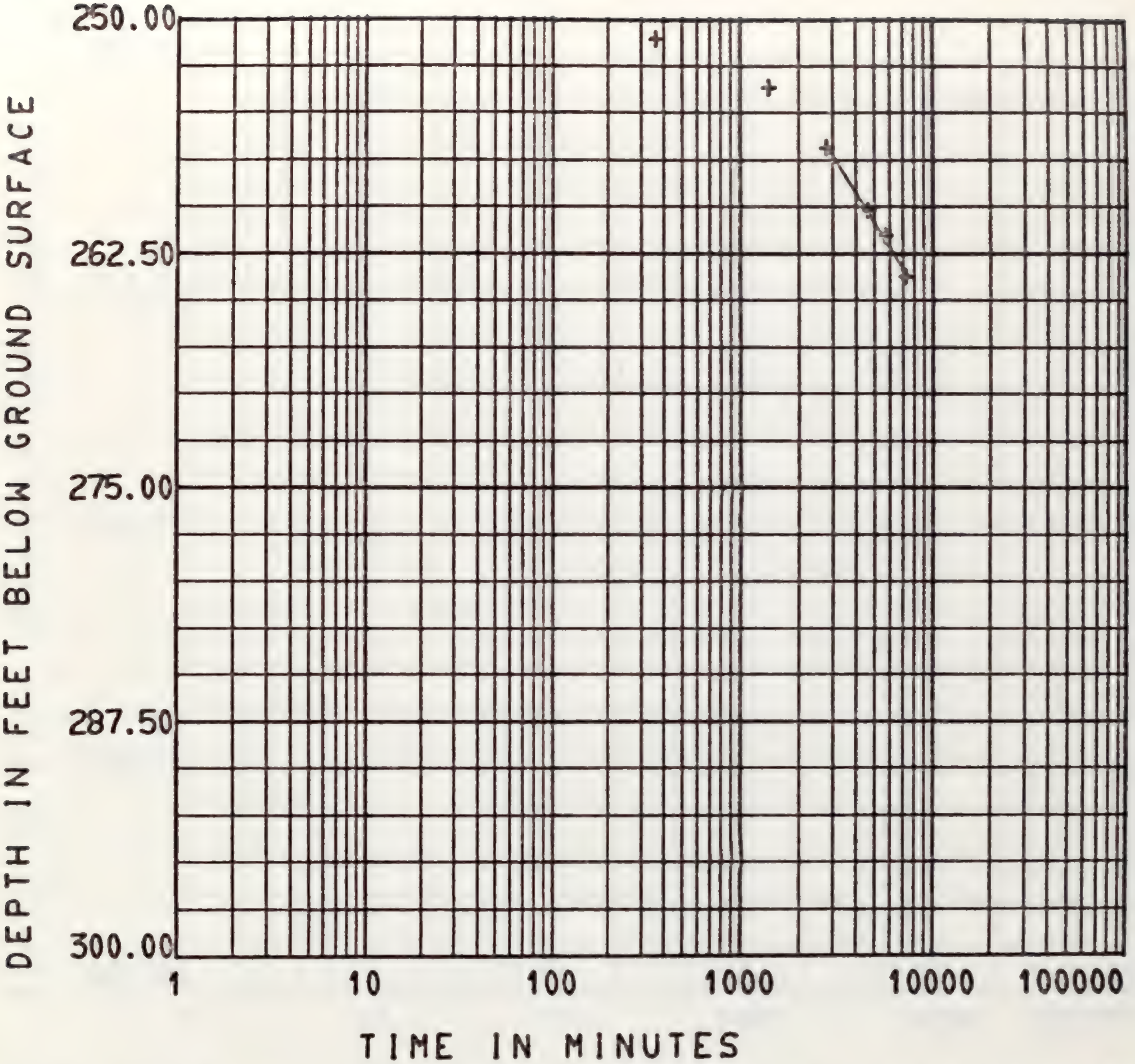
GS-2-3 GS-18 LOWR RECOVERY



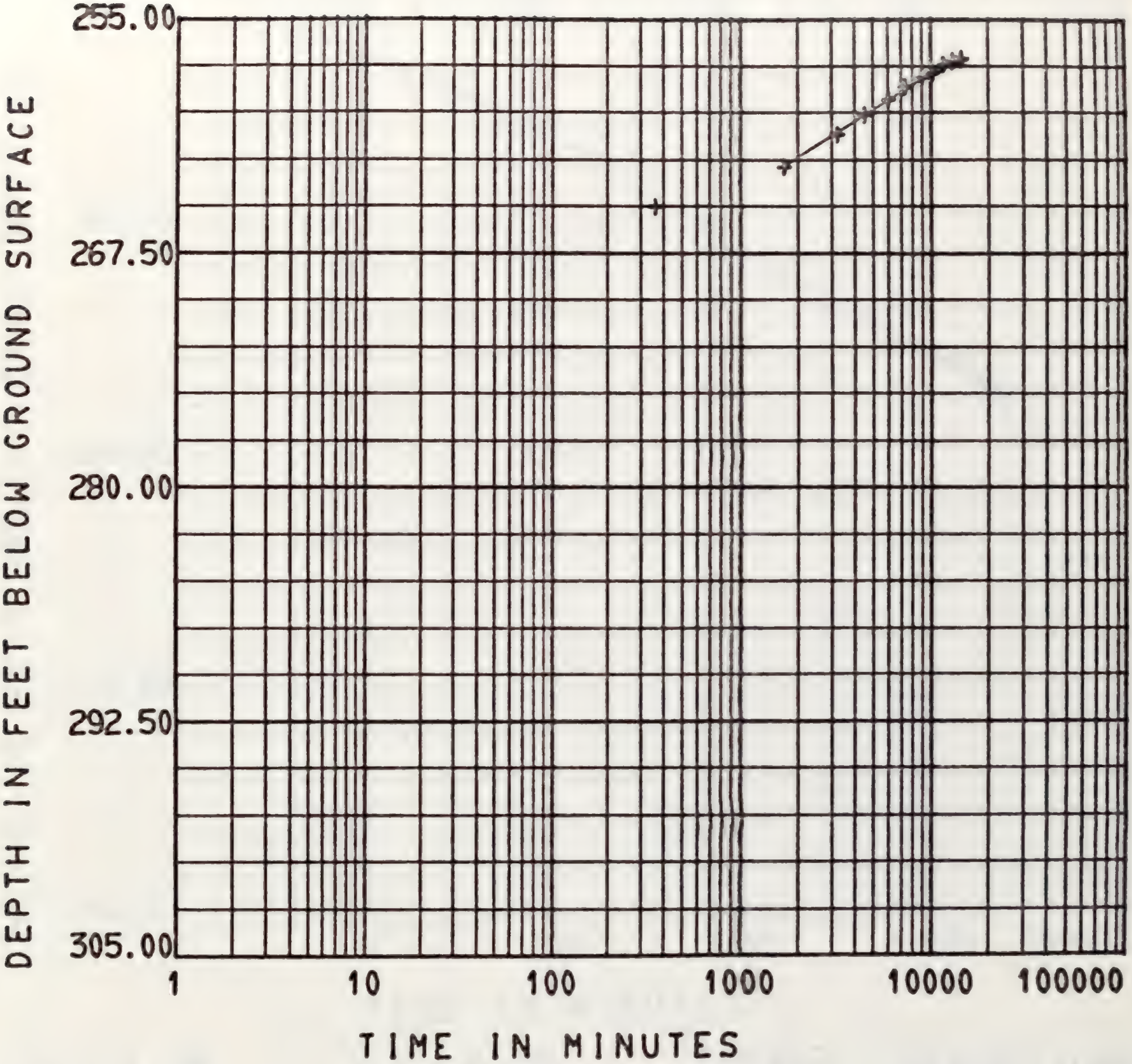
GS-2-3 GS-19 LOWR DRAWDOWN



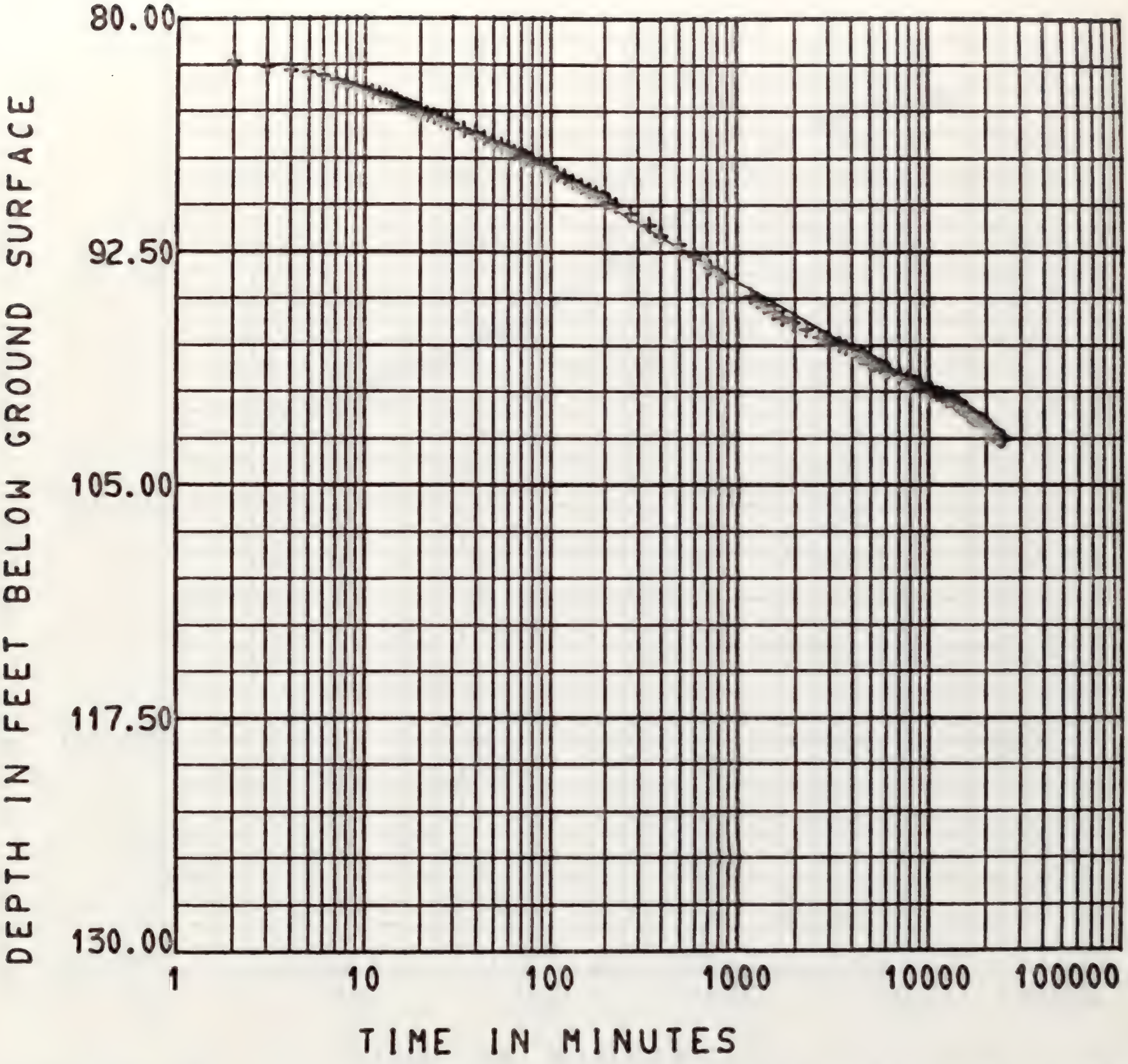
GS-2-3 GS-19 LOWR RECOVERY



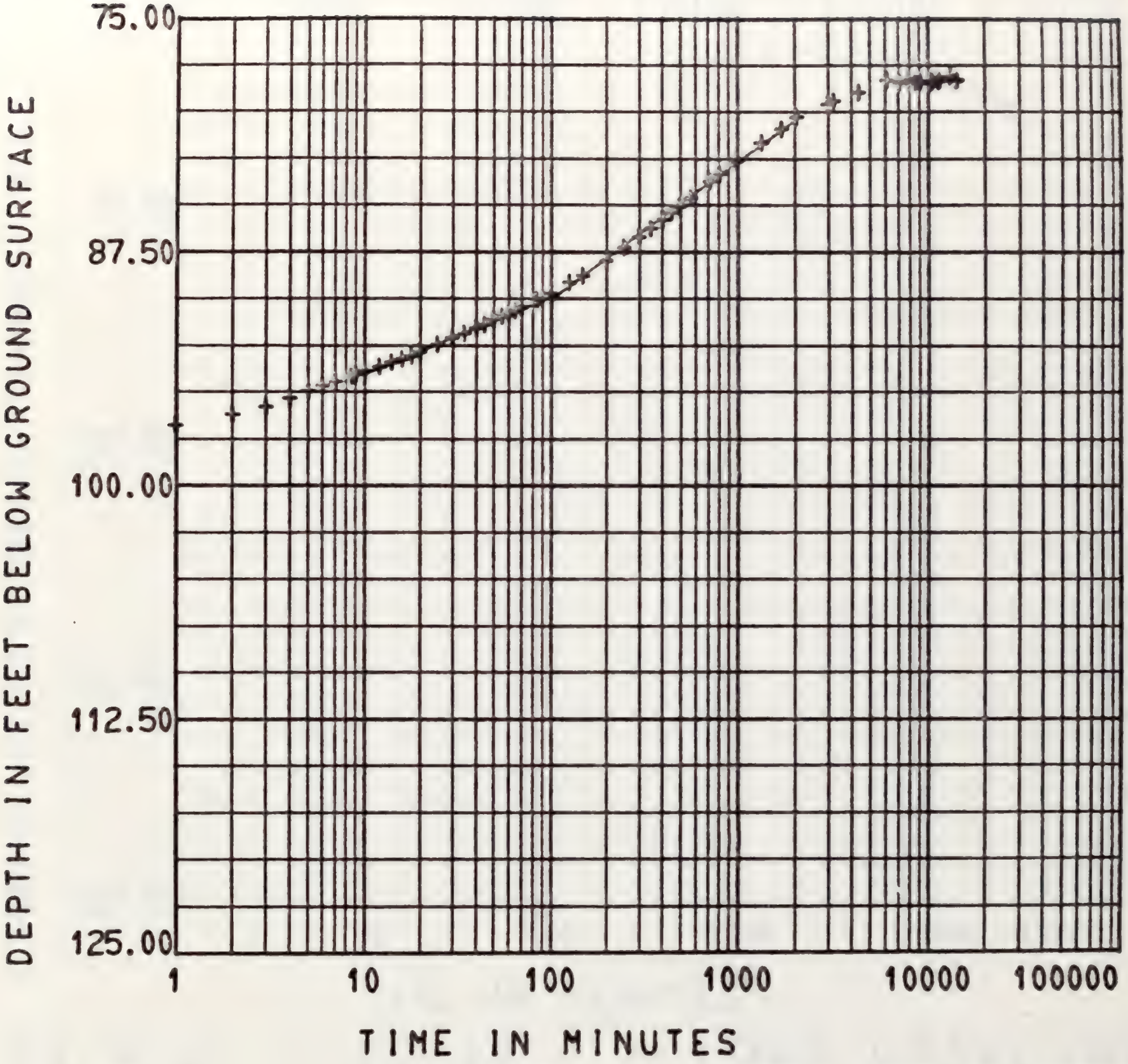
GS-2-3 GS-19 LOWR DRAWDOWN



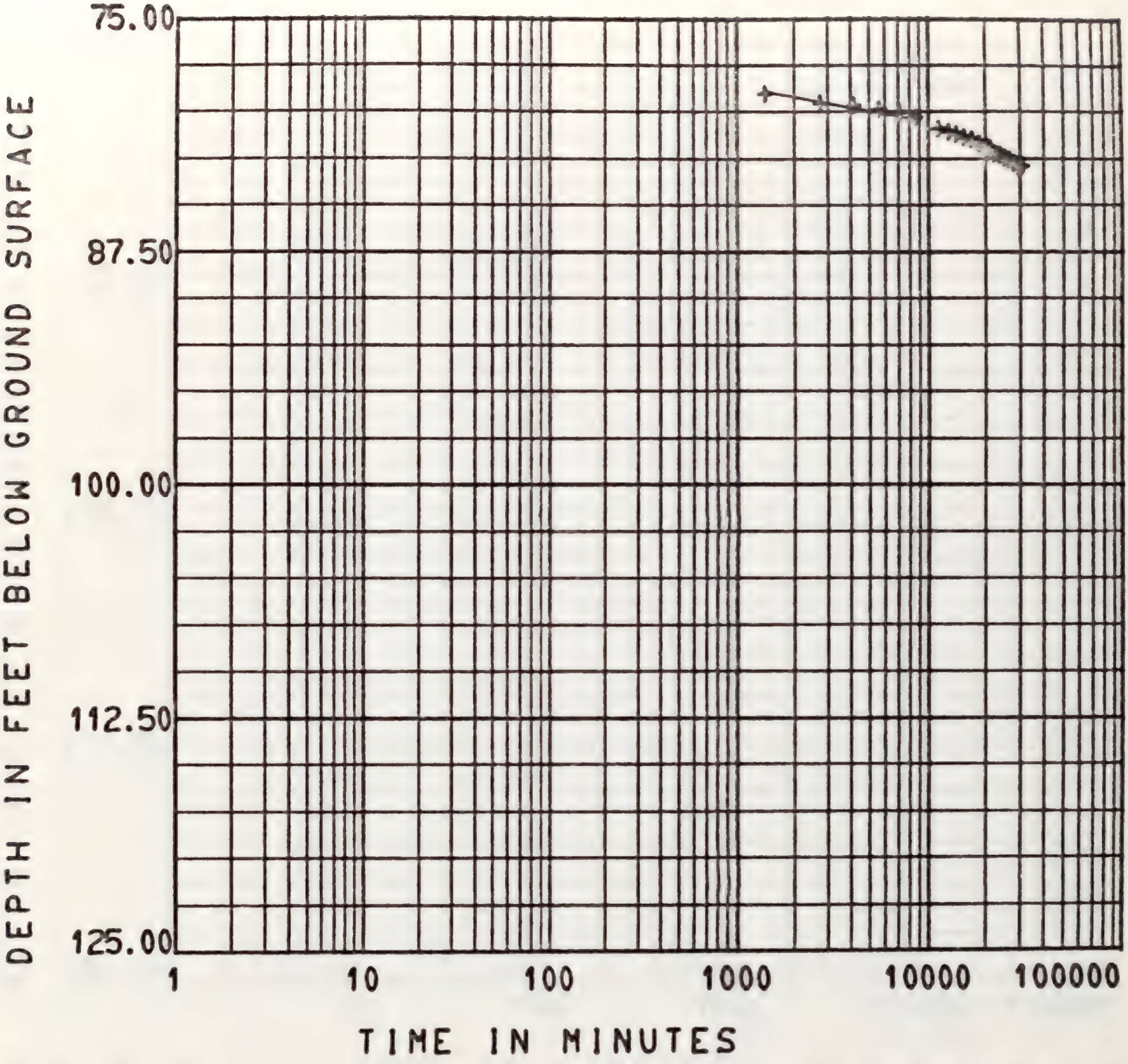
GS-2-3 GS-19 LOWR RECOVERY



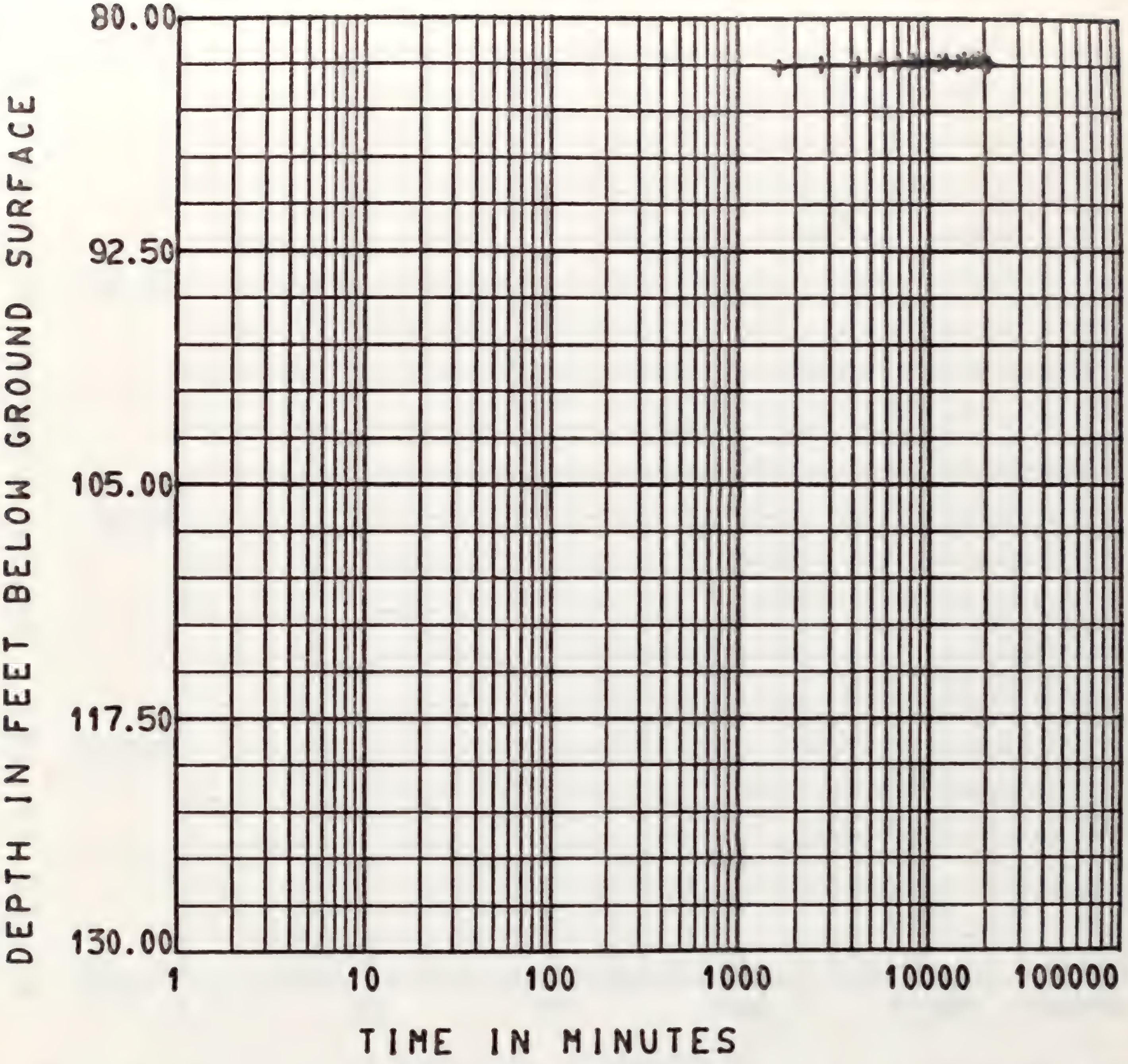
GS-4-5 GS-4-5 UPPR DRAWDOWN



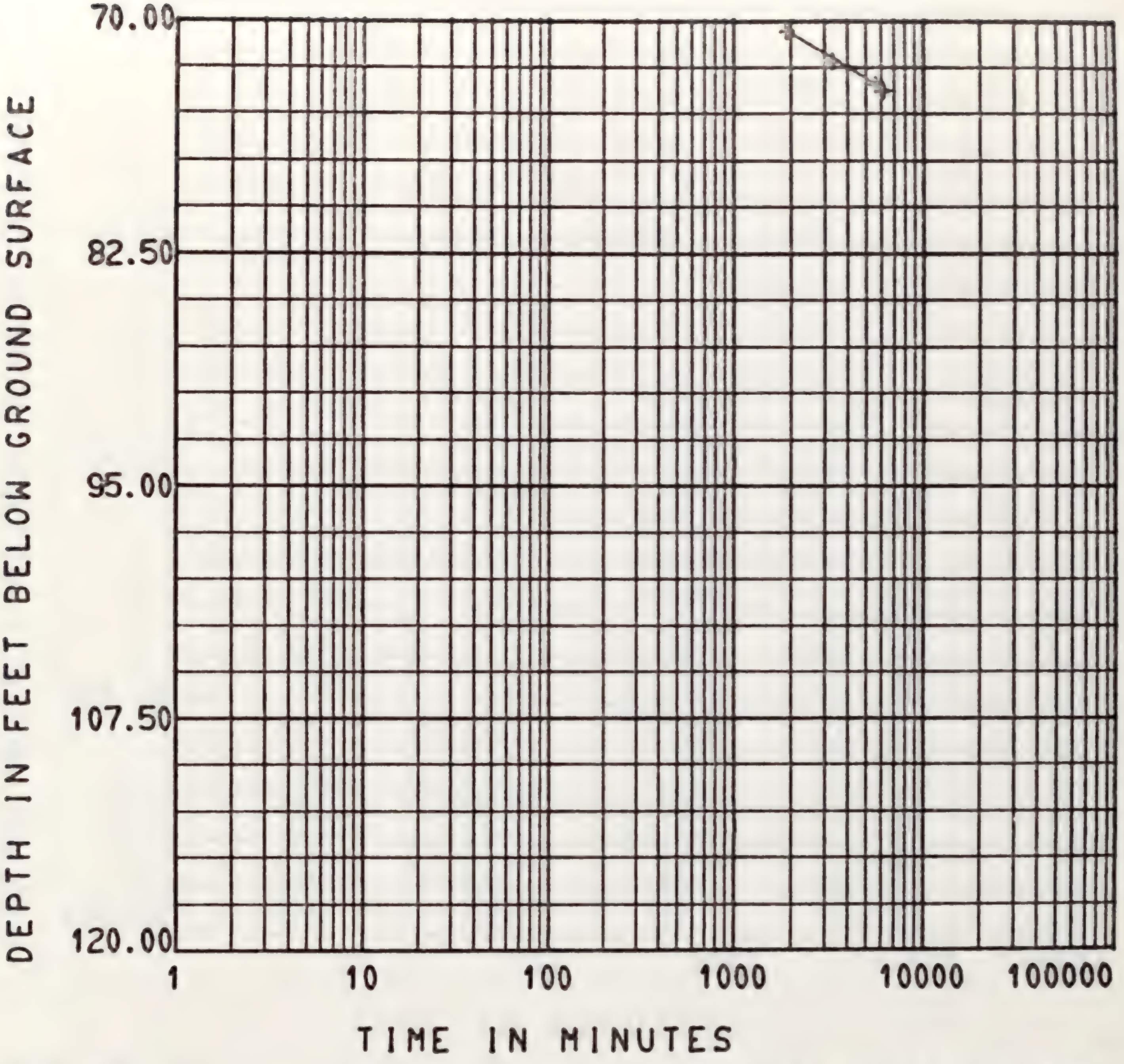
GS-4-5 GS-4-5 UPPR RECOVERY



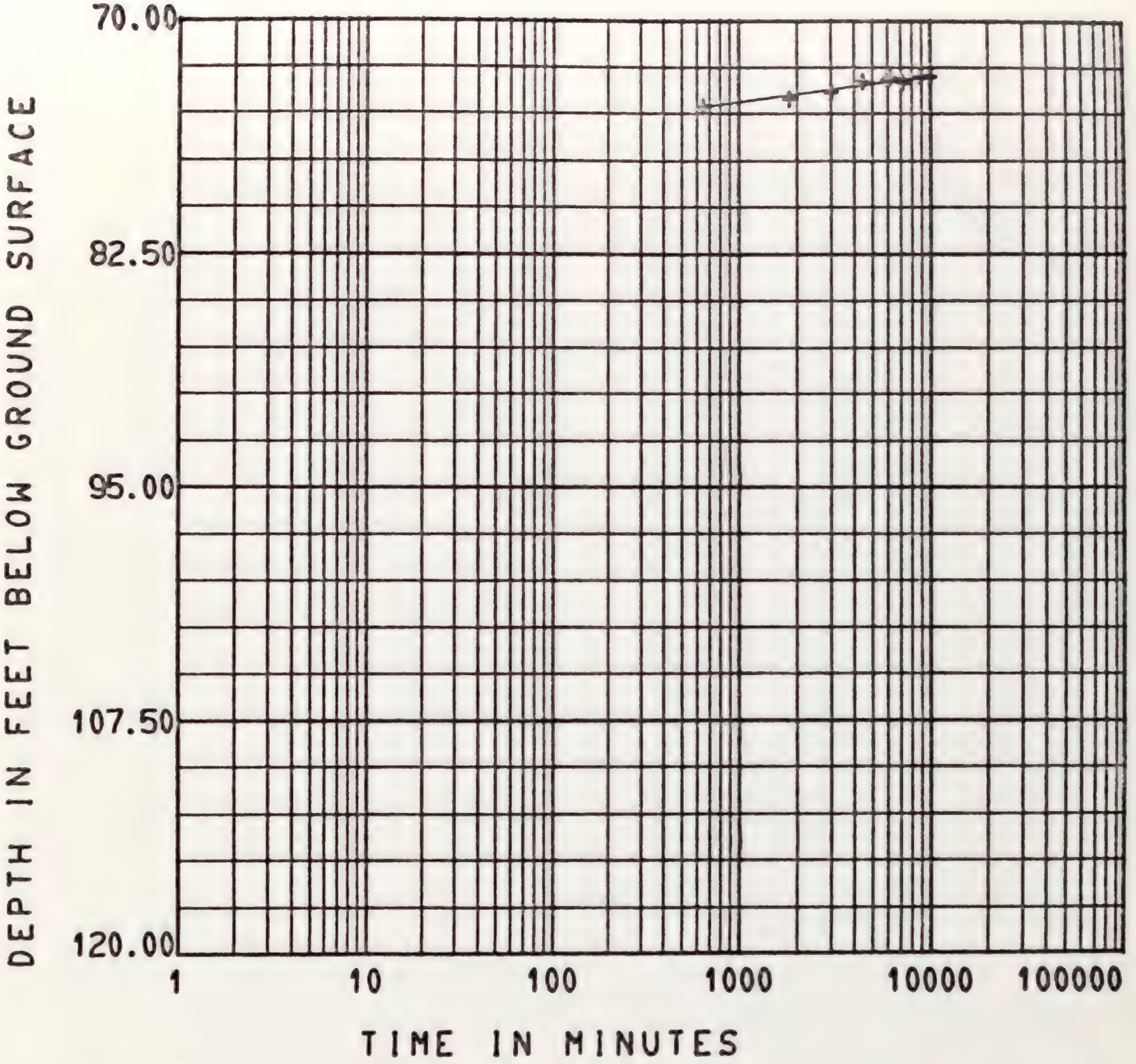
GS-4-5 GS-16 LOWR DRAWDOWN



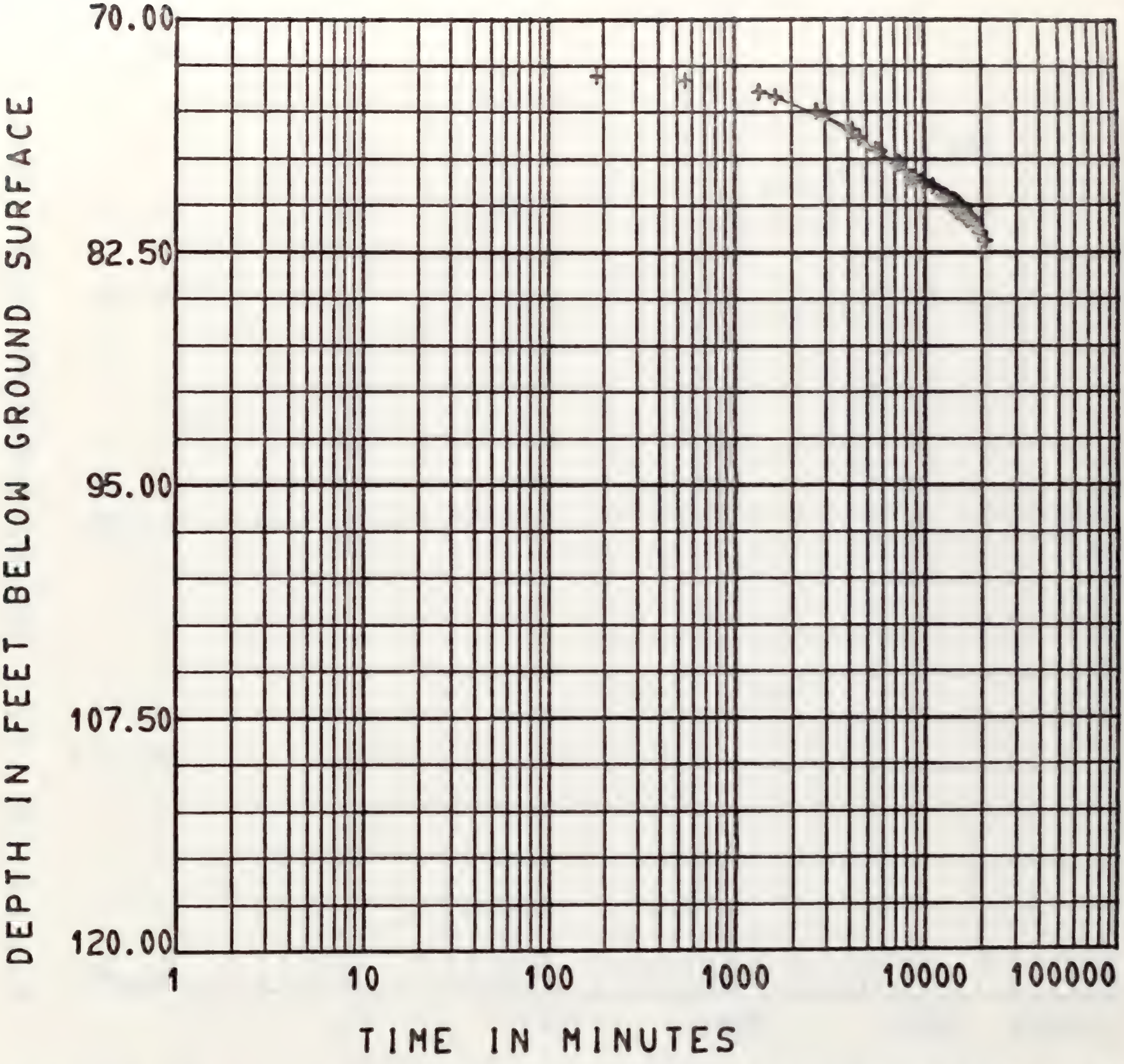
GS-4-5 GS-16 LOWR RECOVERY



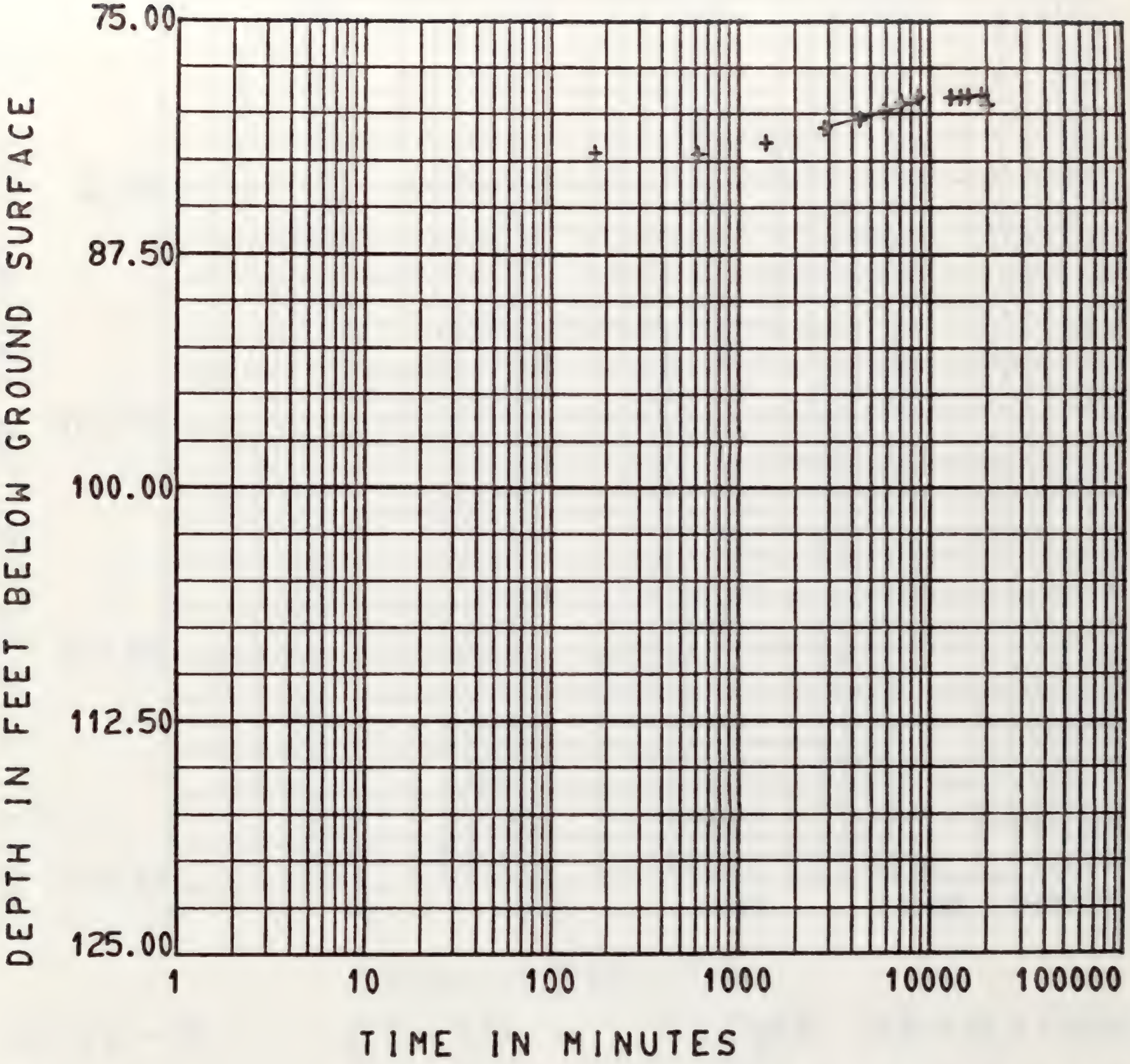
GS-4-5 GS-17 LOWR DRAWDOWN



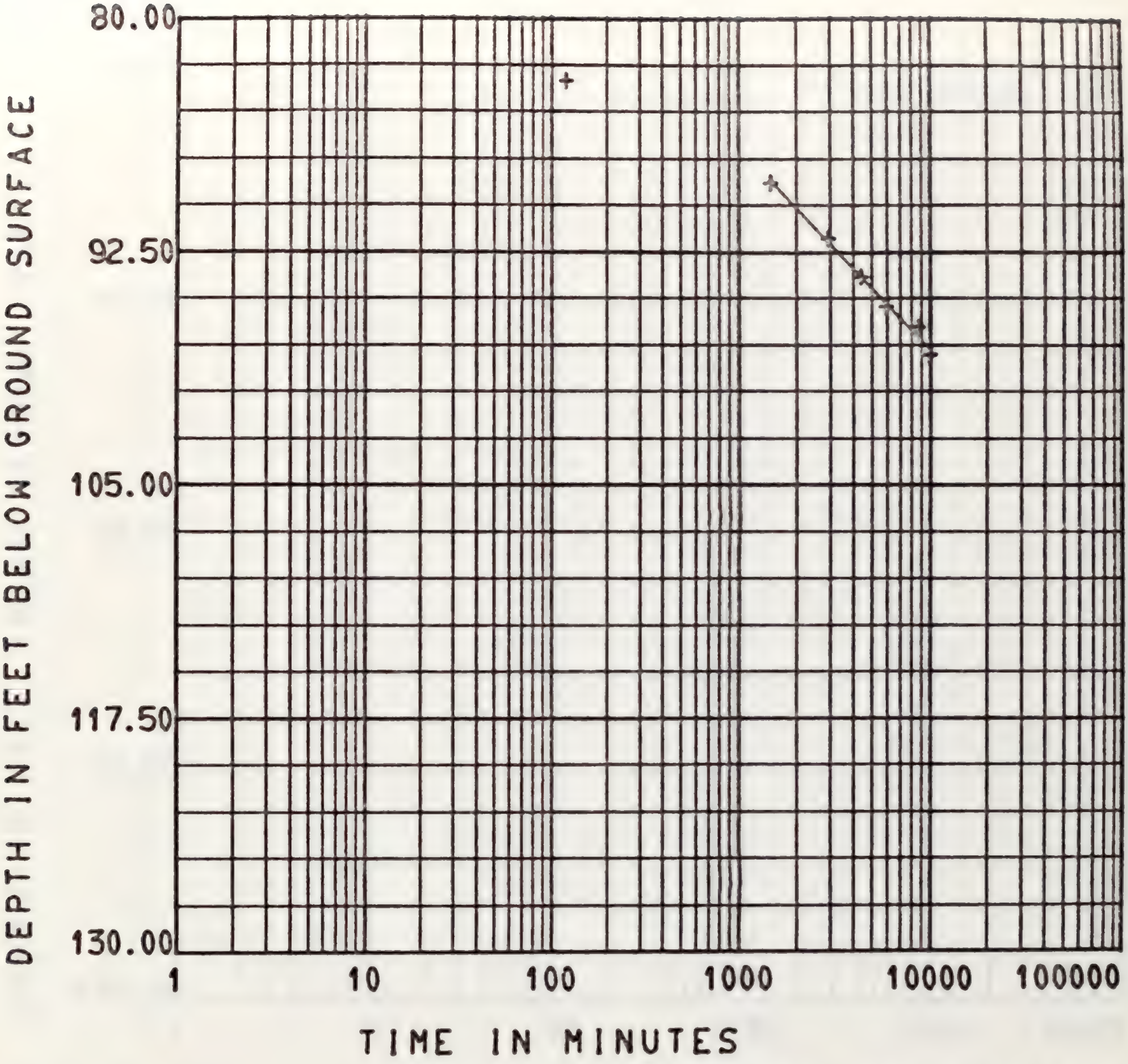
GS-4-5 GS-17 LOWR RECOVERY



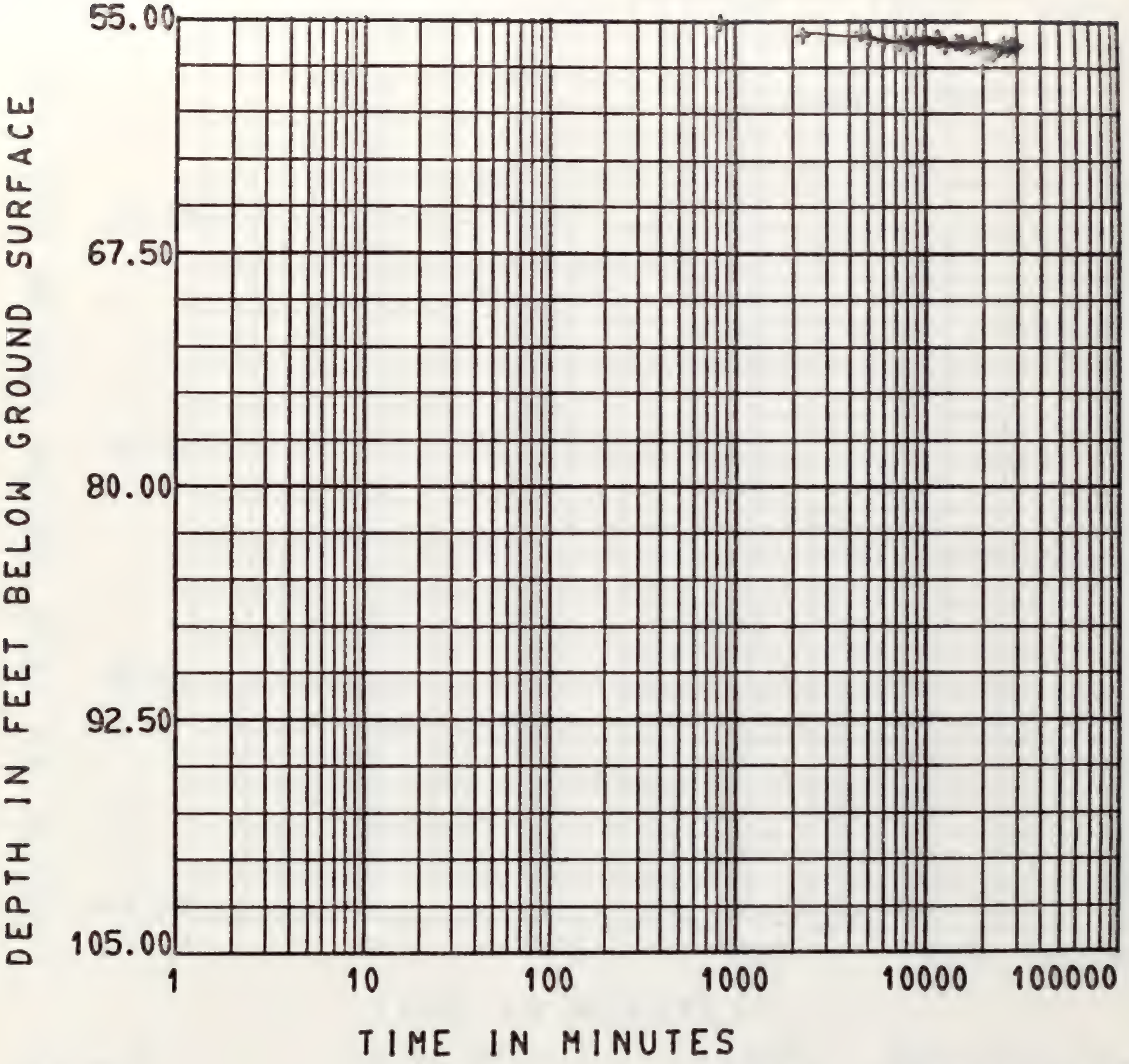
GS-4-5 GS-17 LOWR DRAWDOWN



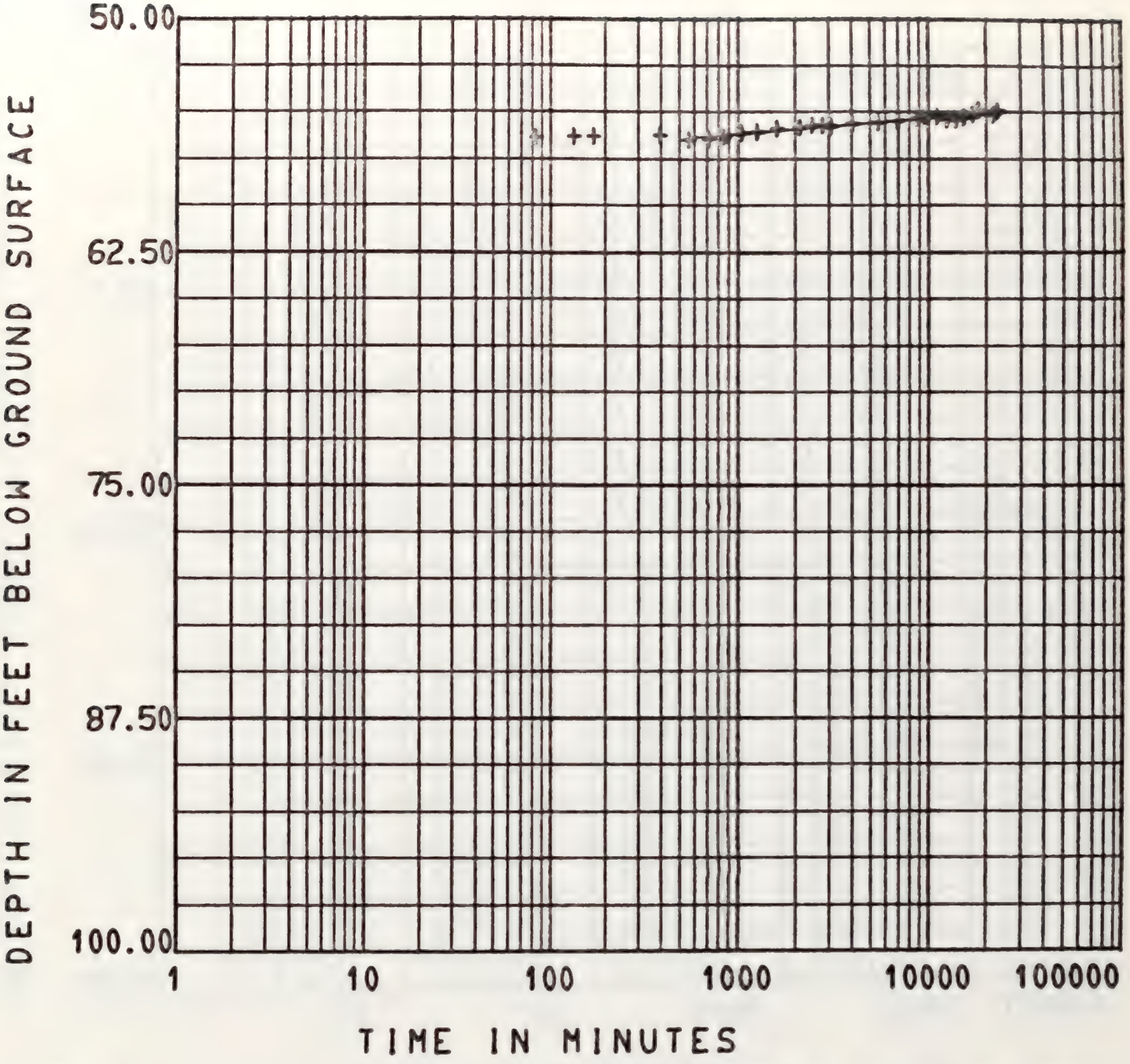
GS-4-5 GS-17 LOWR RECOVERY



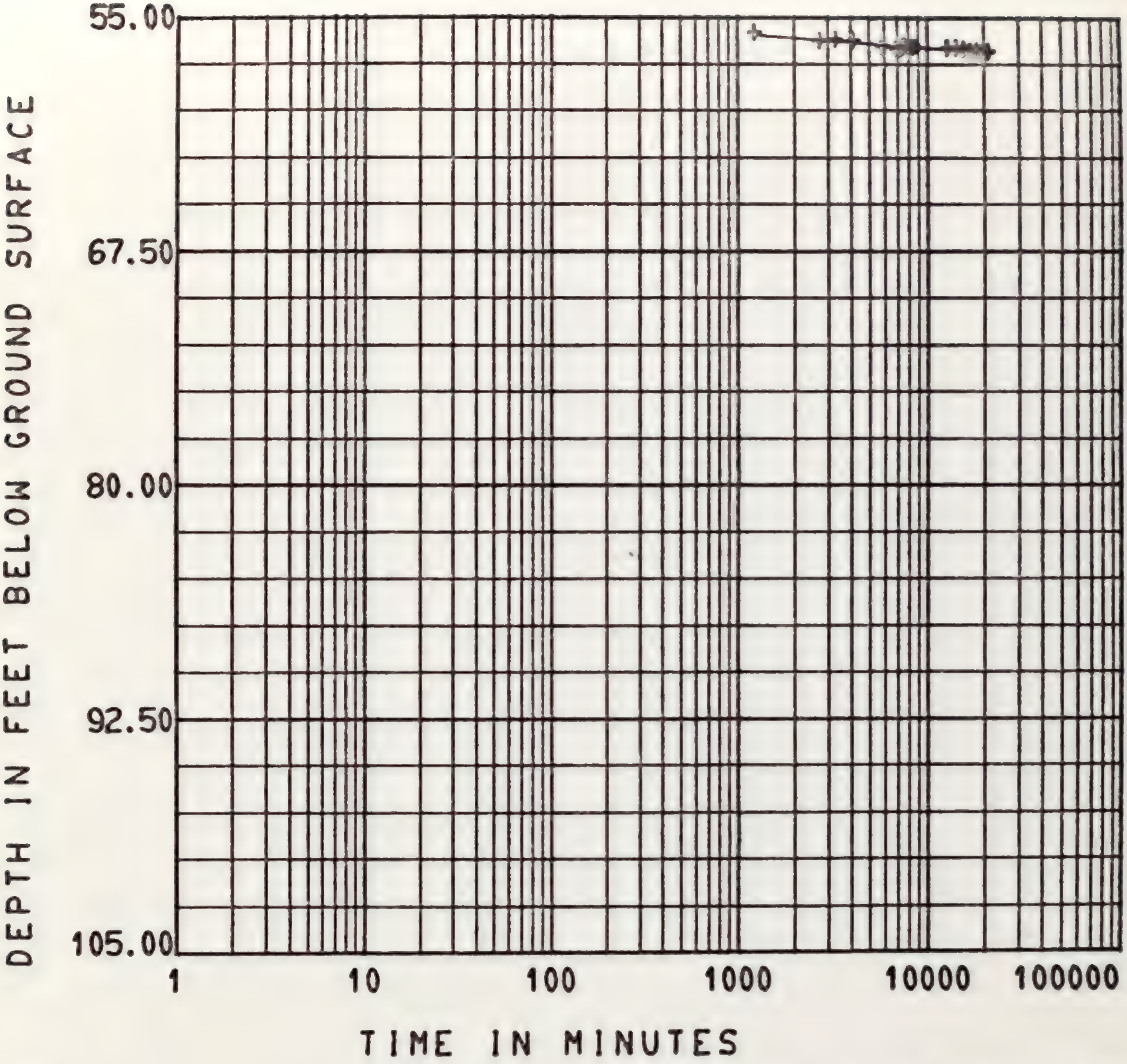
GS-4-5 GS-19 LOWR DRAWDOWN



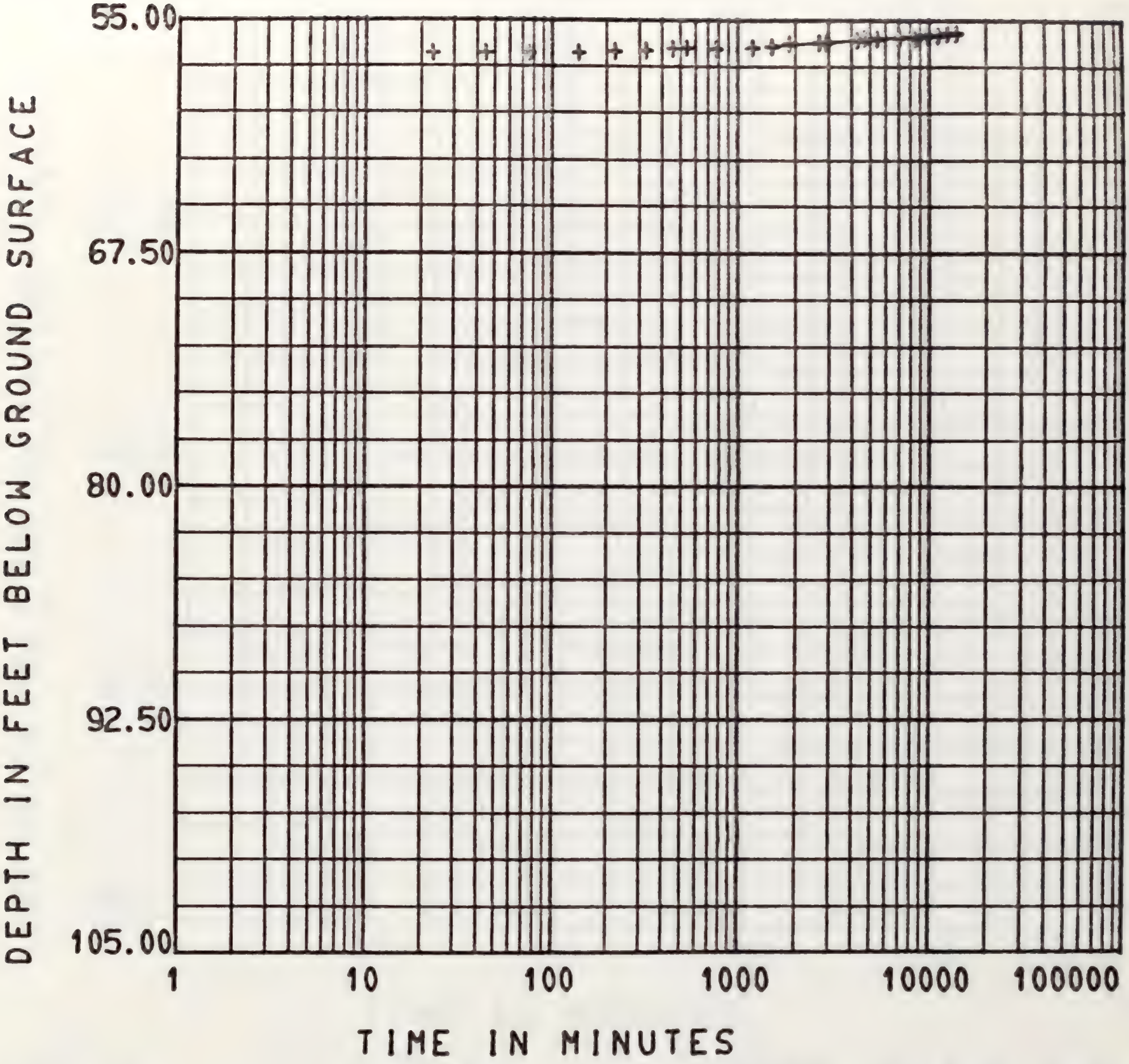
GS-6 TO-3 UPPR DRAWDOWN



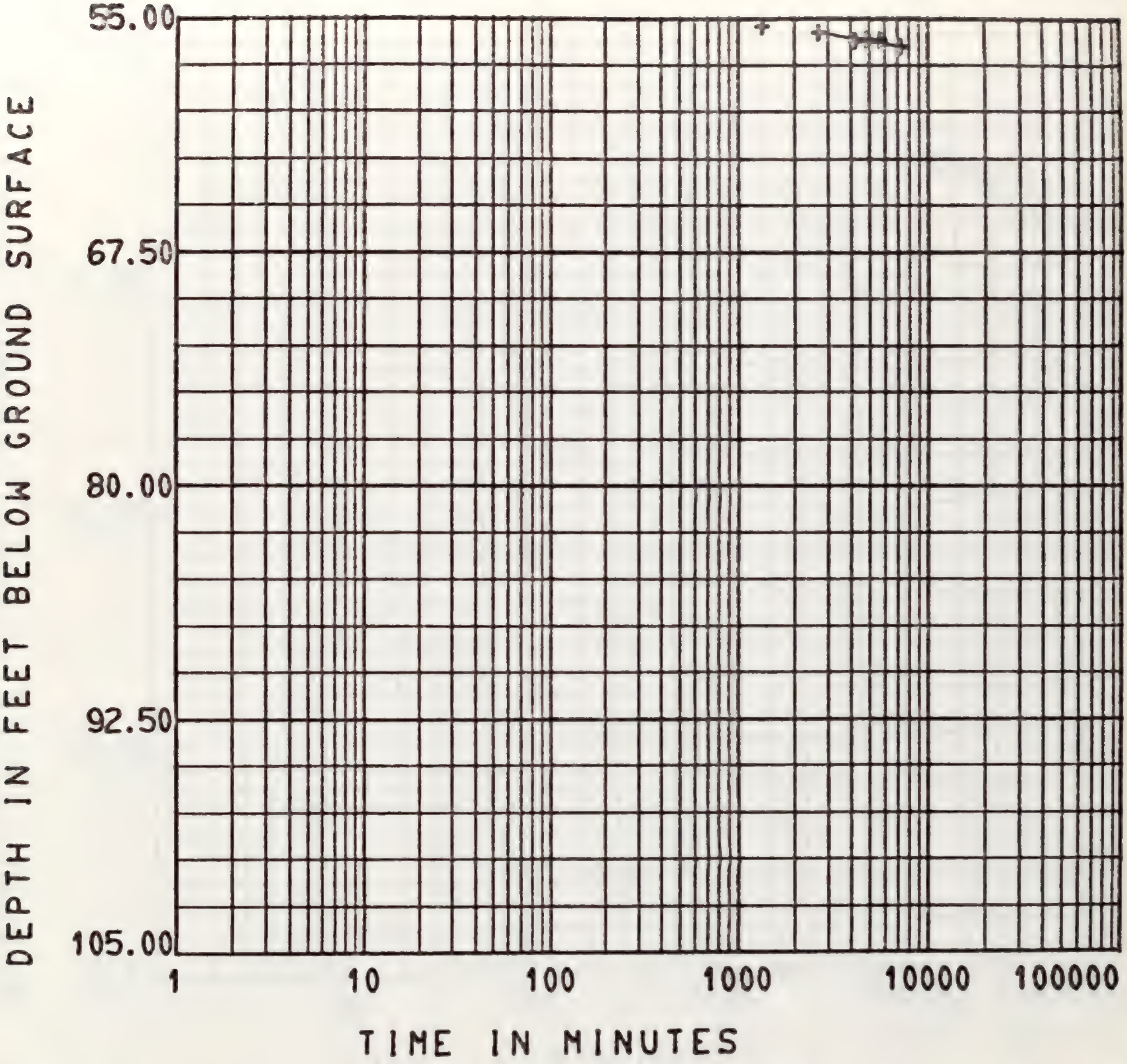
GS-6 TO-3 UPPR RECOVERY



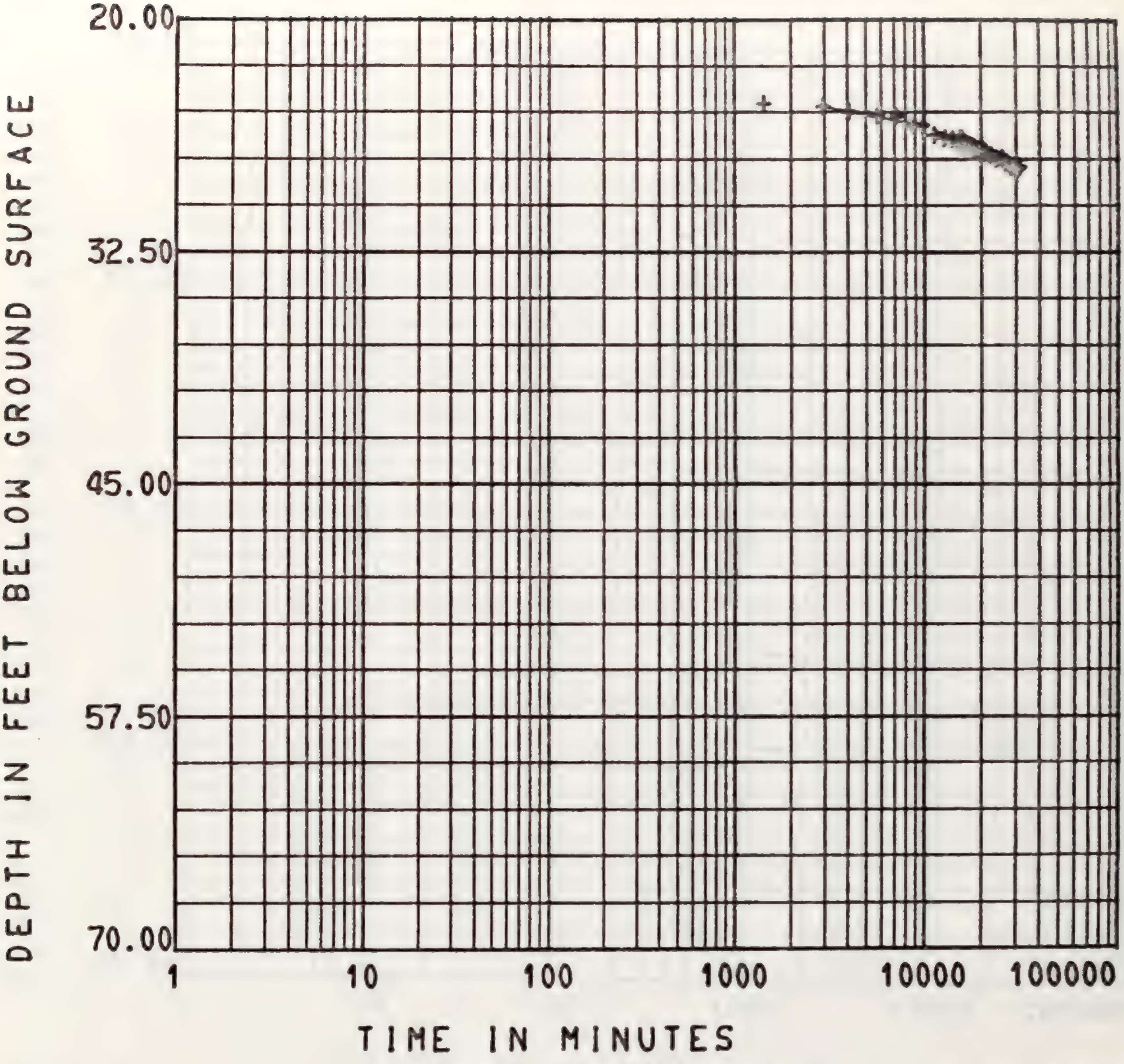
GS-6 GS-18 UPPR DRAWDOWN



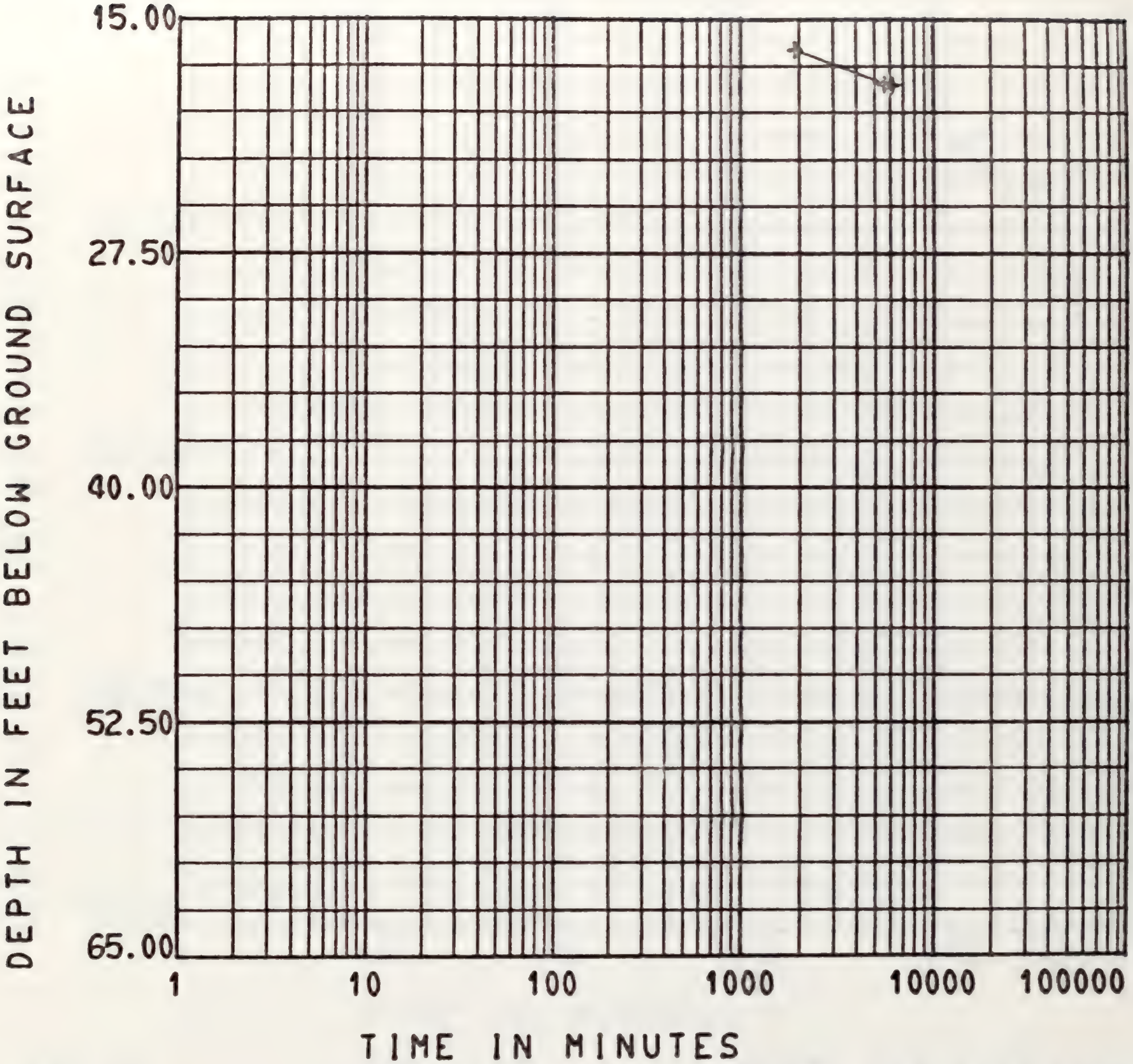
GS-6 GS-18 UPPR RECOVERY



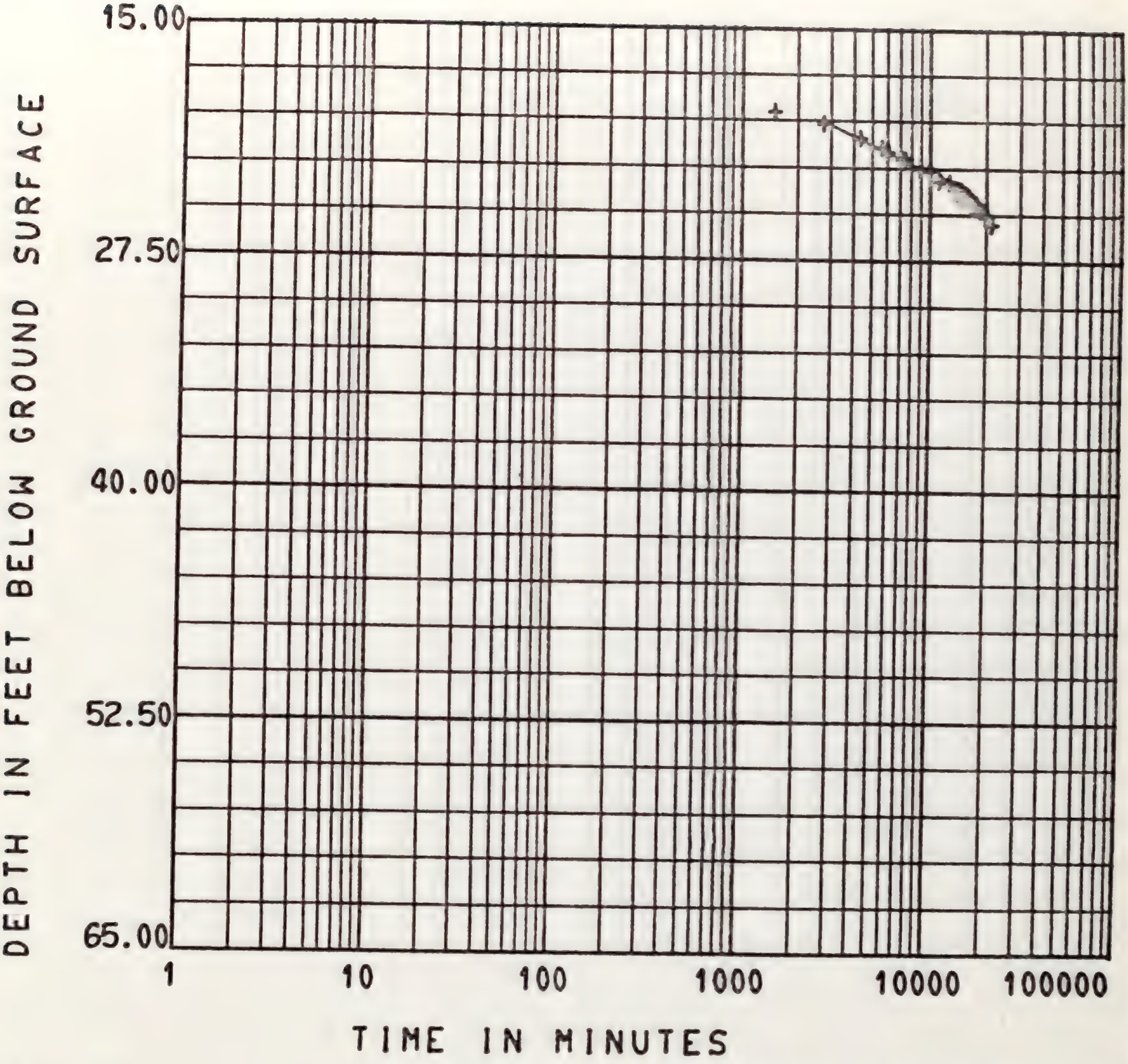
GS-6 GS-19 UPPR DRAWDOWN



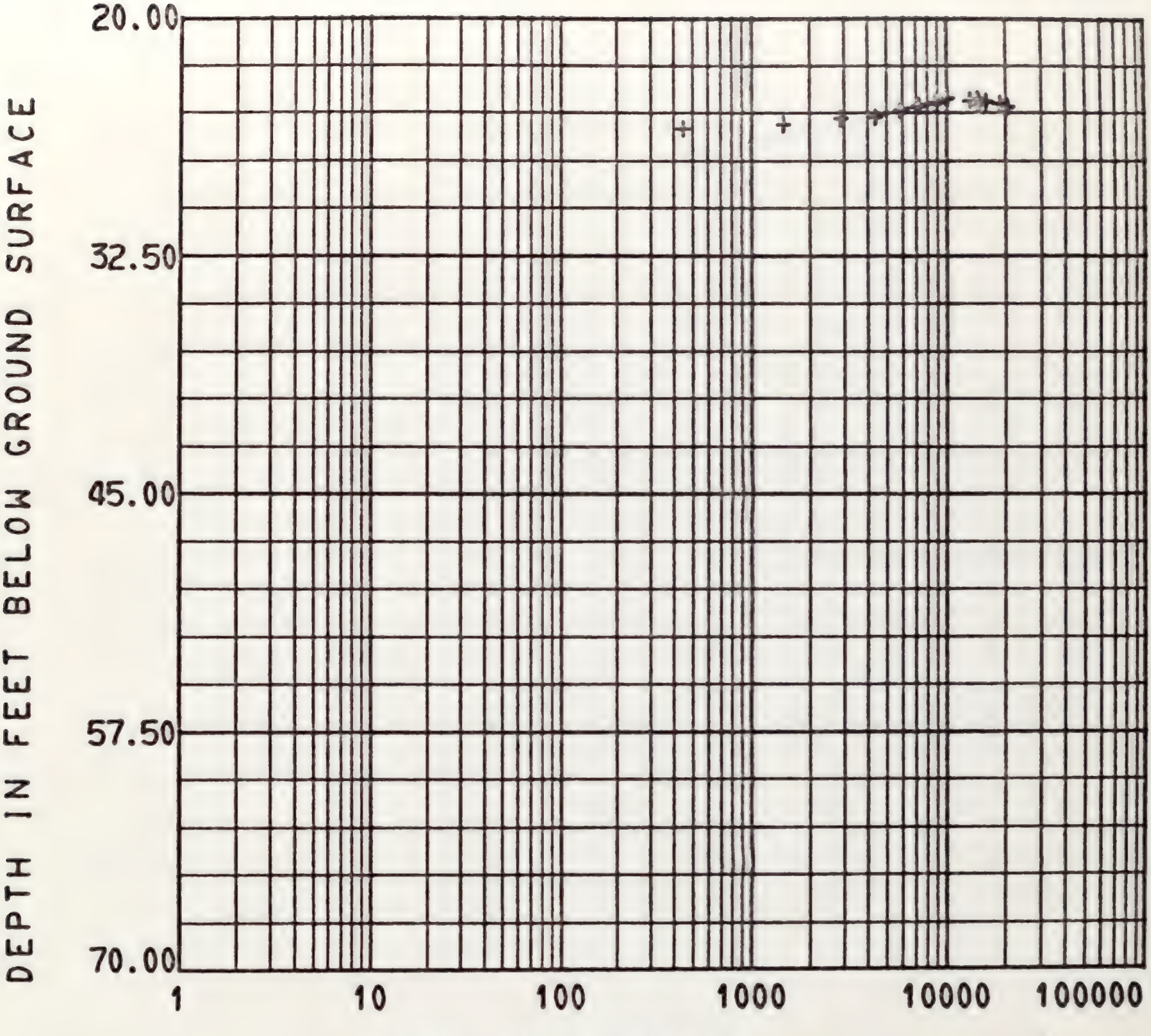
GS-6 GS-16 LOWR DRAWDOWN



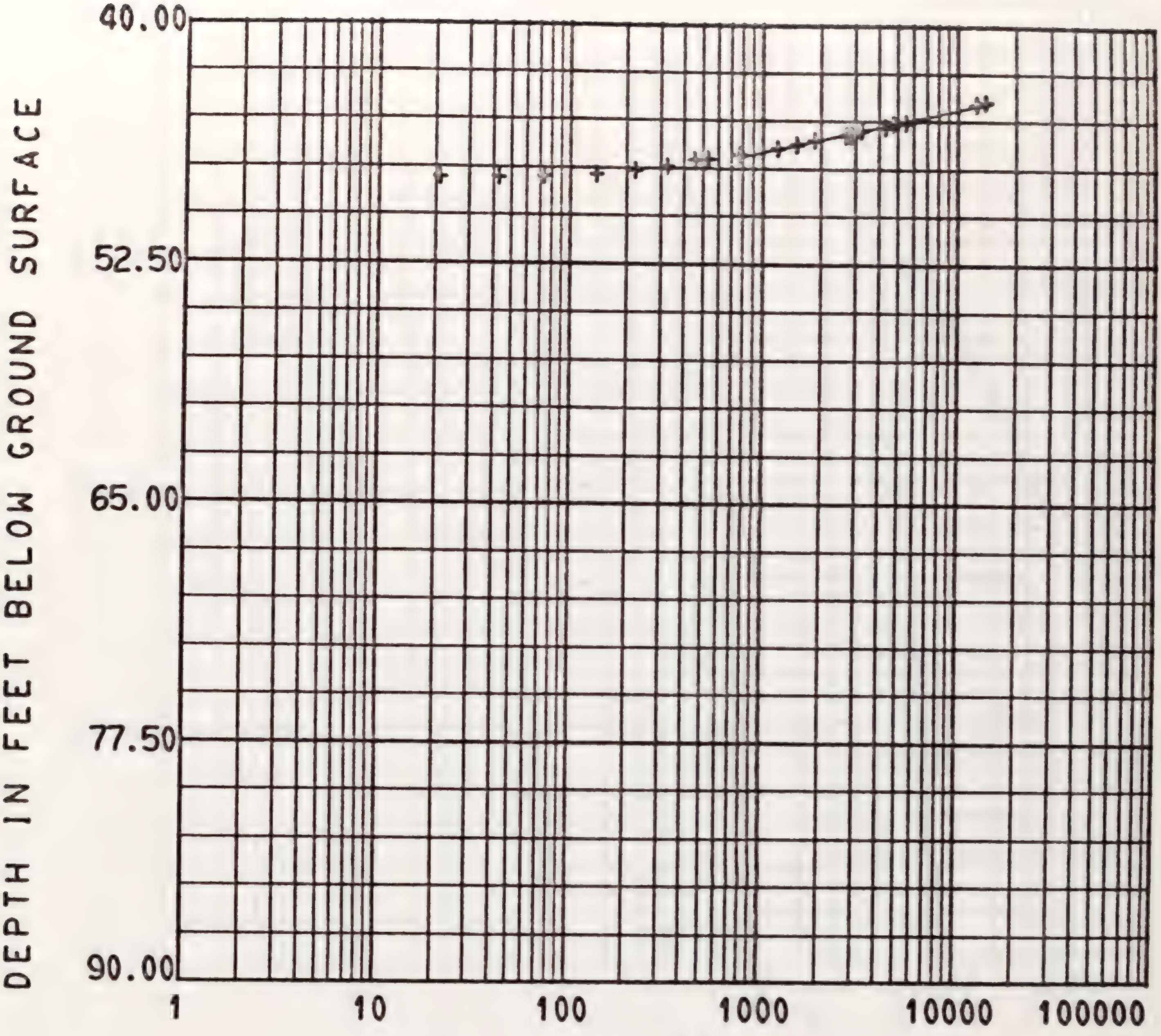
GS-6 GS-17 LOWR DRAWDOWN



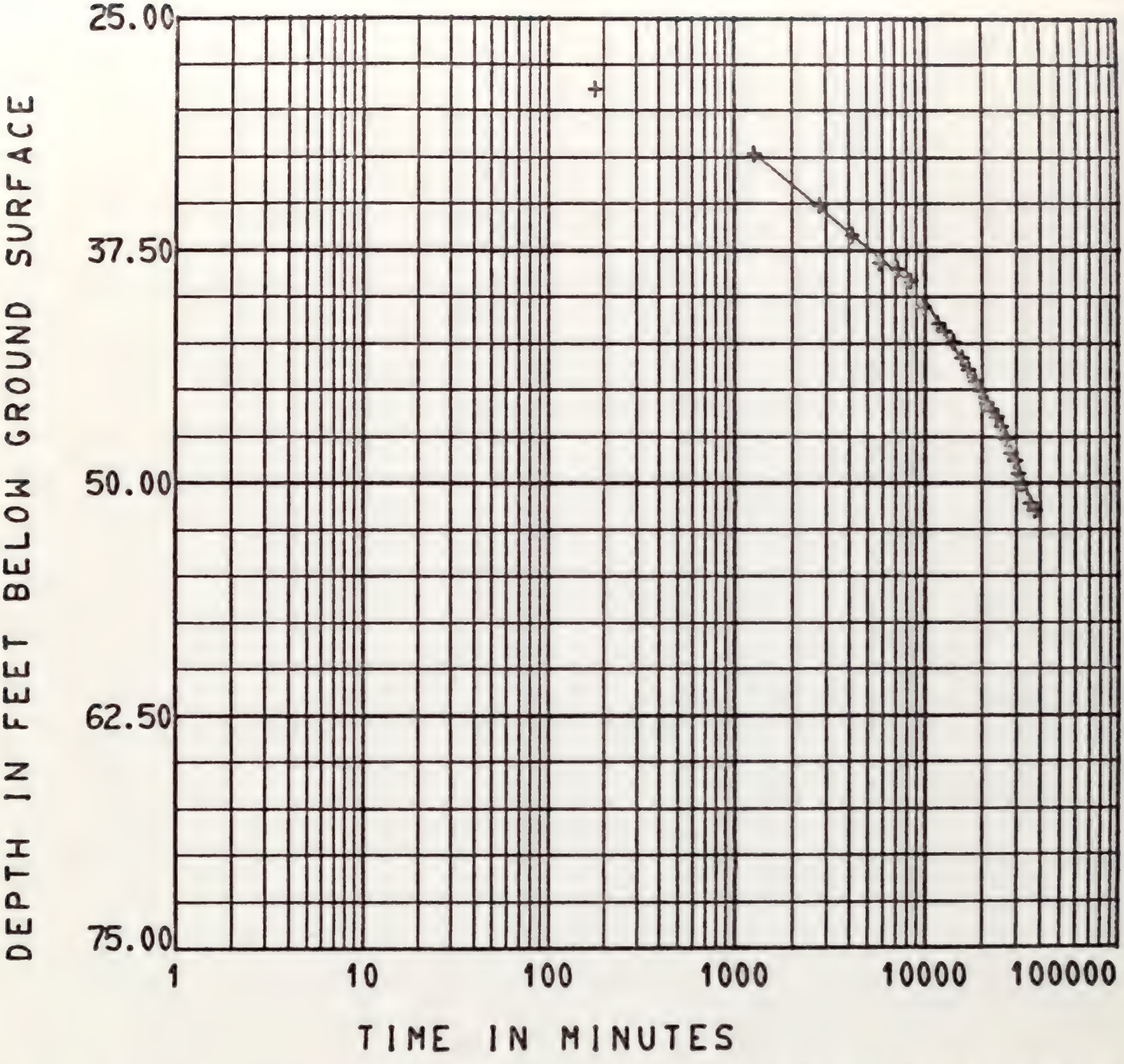
GS-6 GS-17 LOWR DRAWDOWN



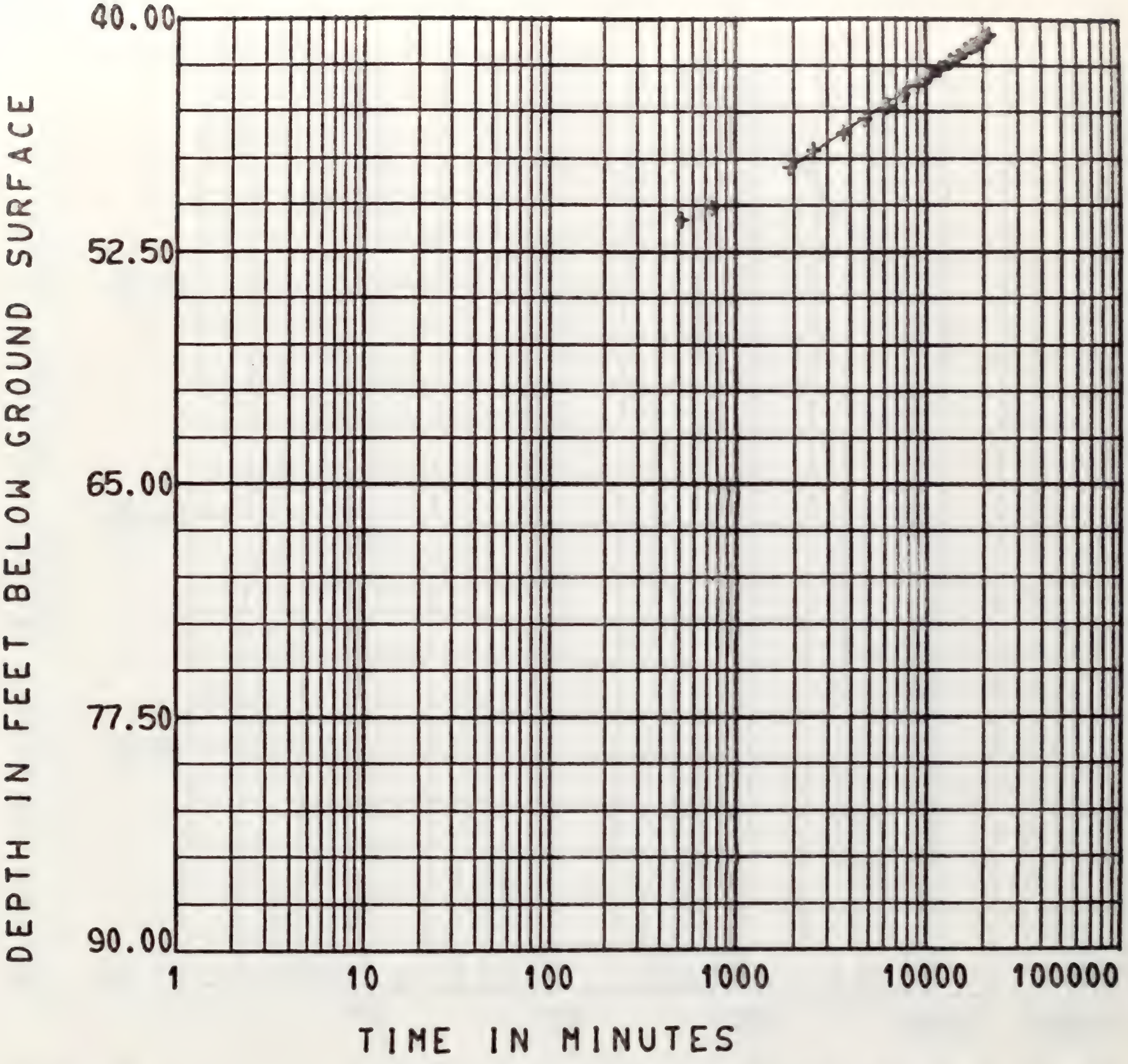
GS-6 GS-17 LOWR RECOVERY



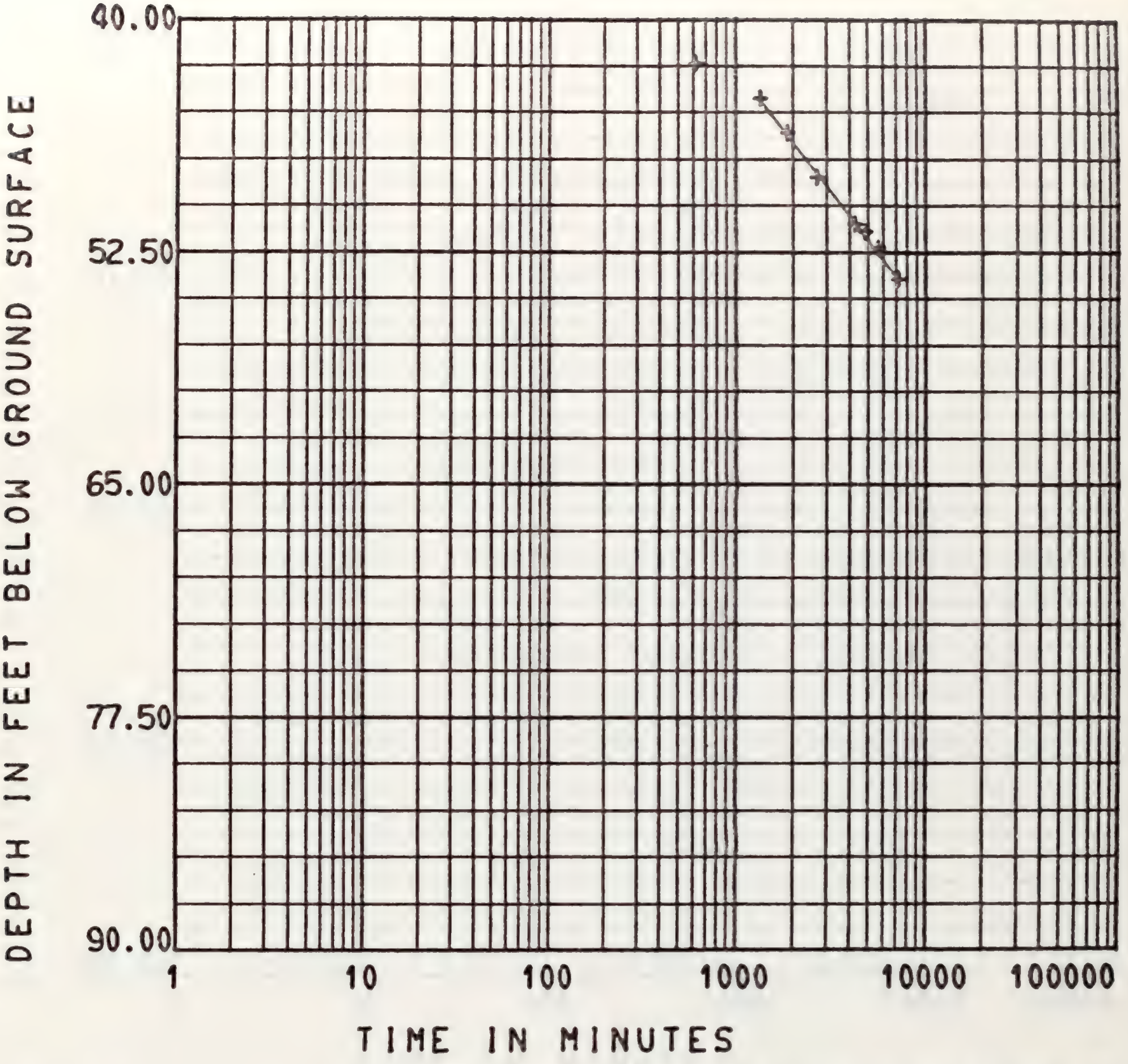
GS-6 GS-18 LOWR RECOVERY



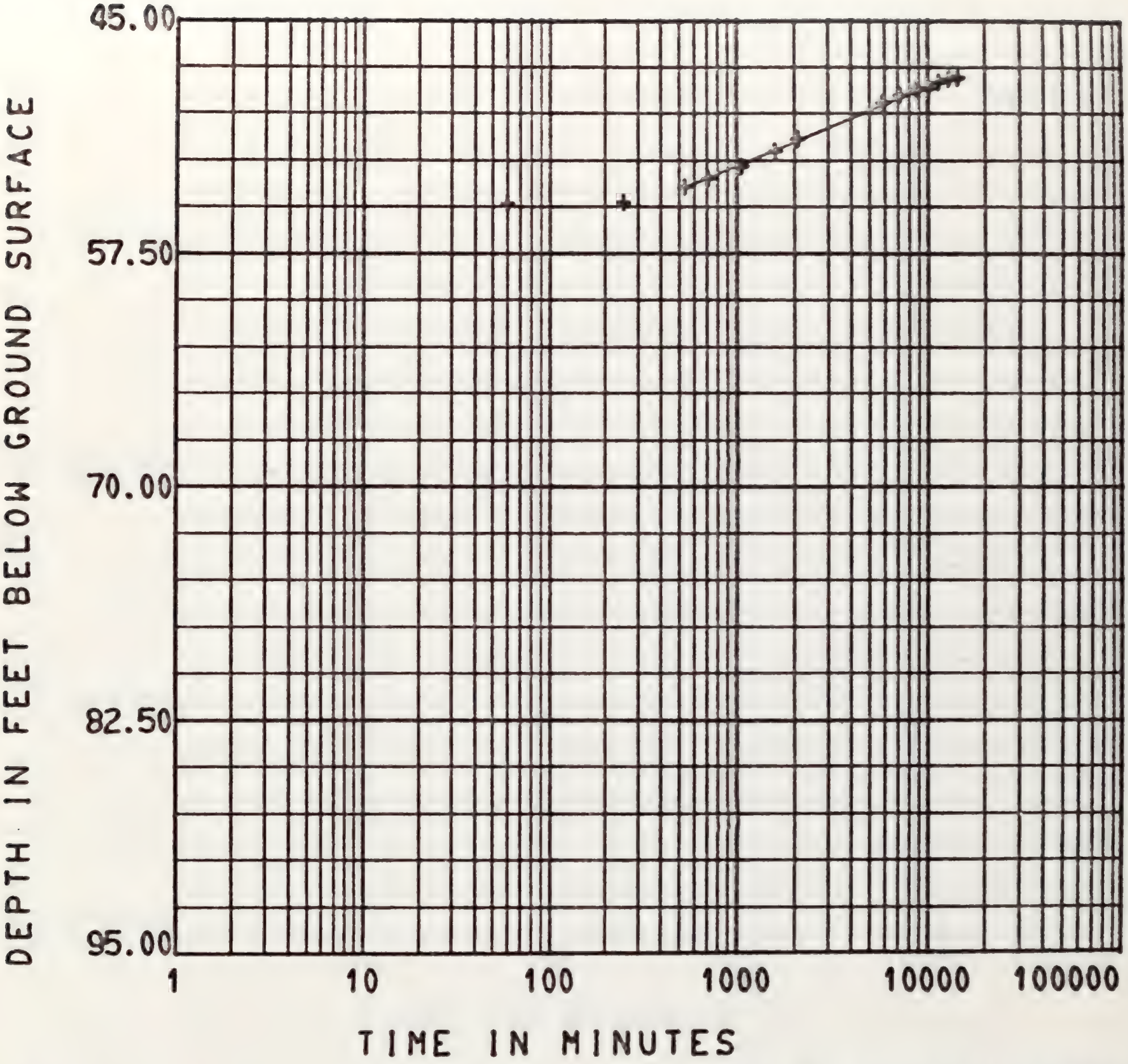
GS-6 GS-19 LOWR DRAWDOWN



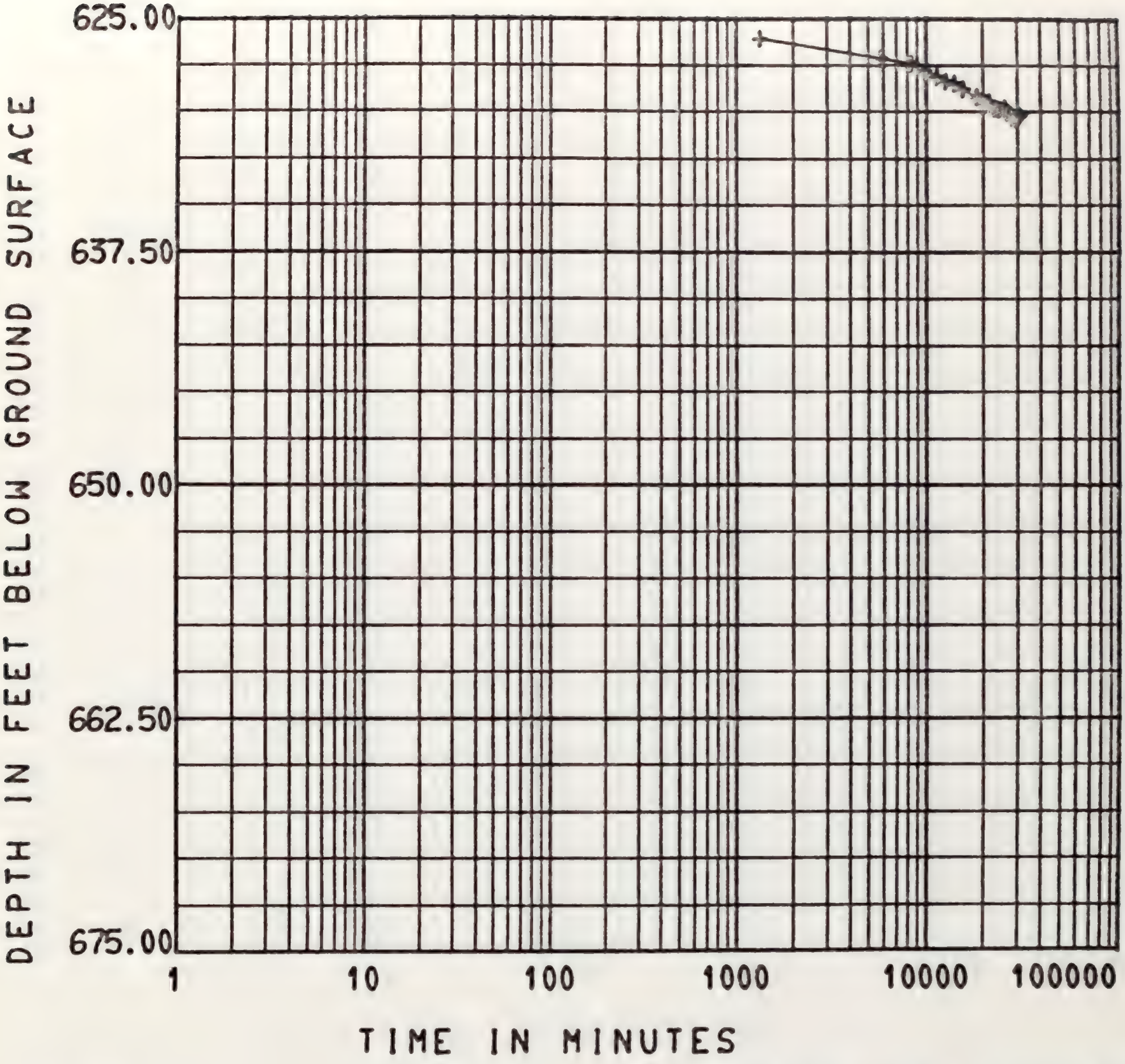
GS-6 GS-19 LOWR RECOVERY



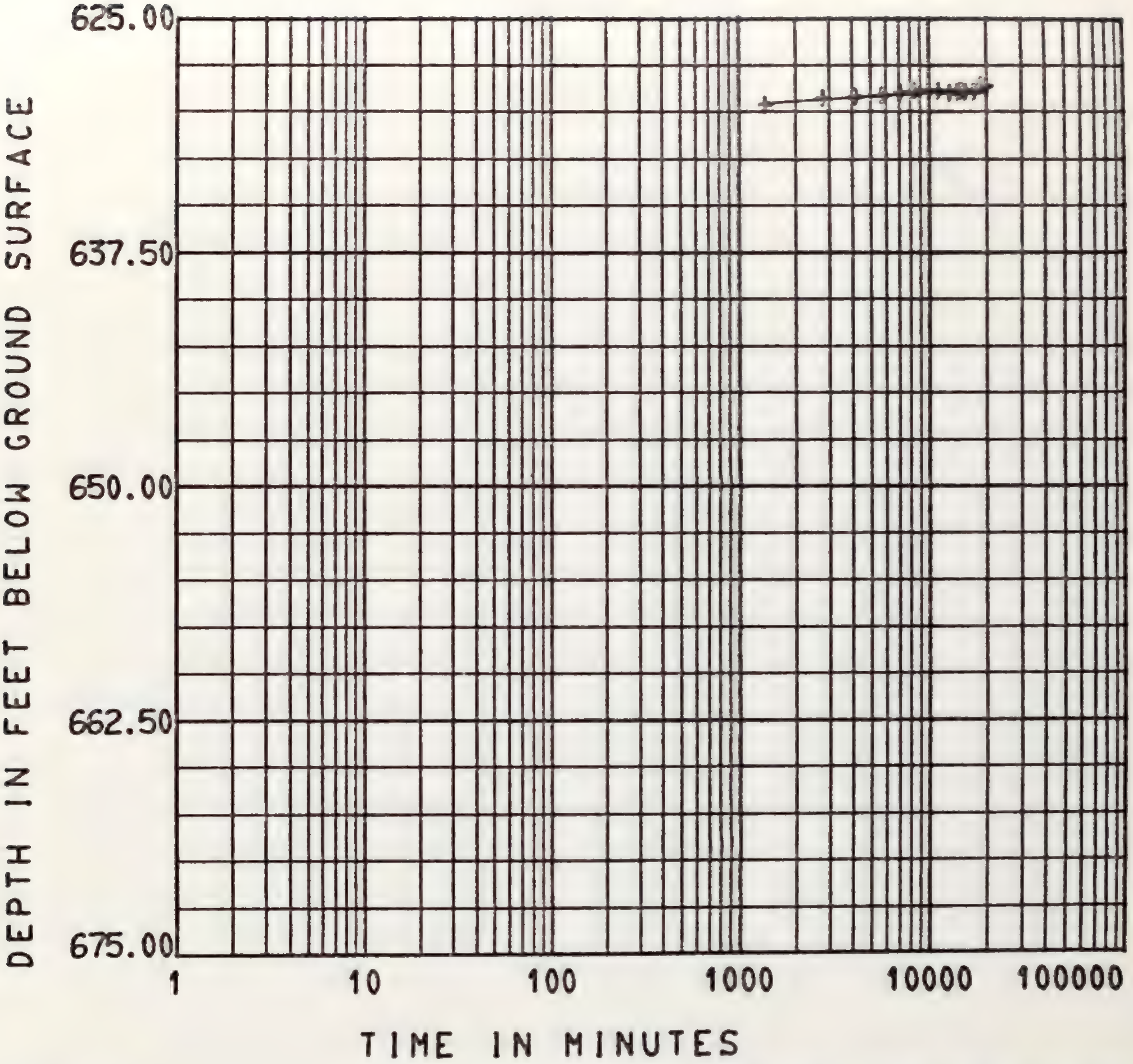
GS-6 GS-19 LOWR DRAWDOWN



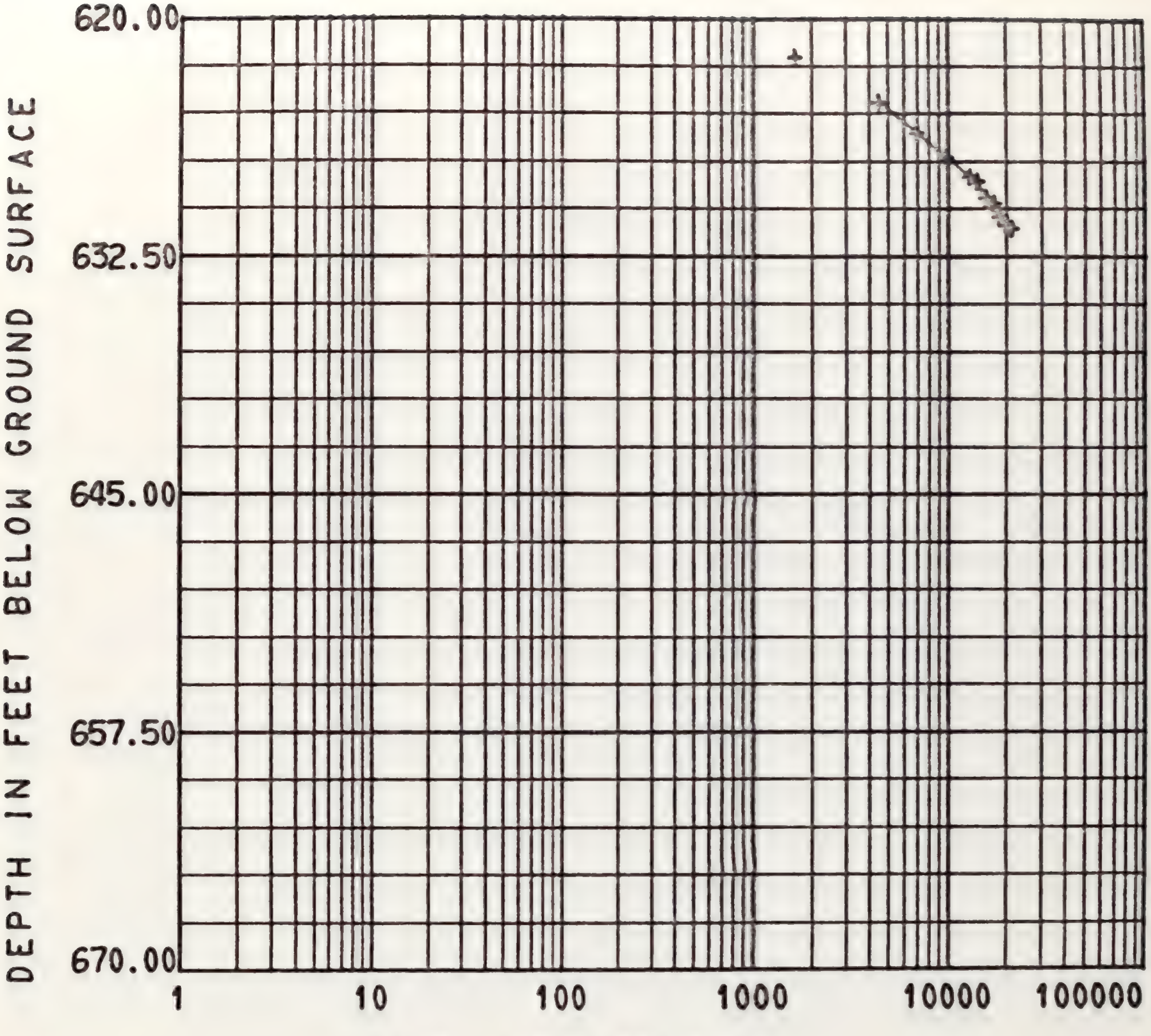
GS-6 GS-19 LOWR RECOVERY



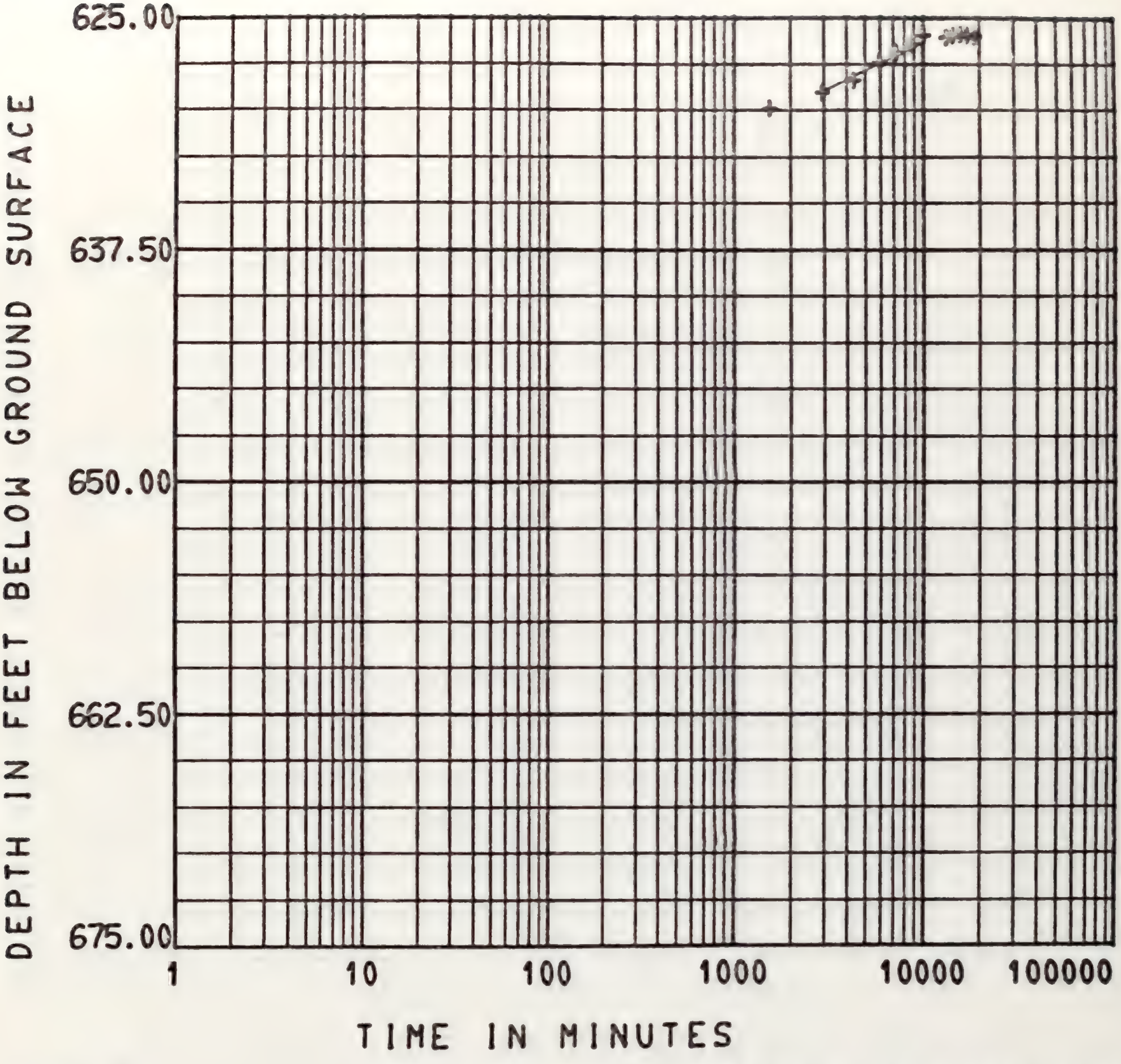
GS-8 GS-16 LOWR DRAWDOWN



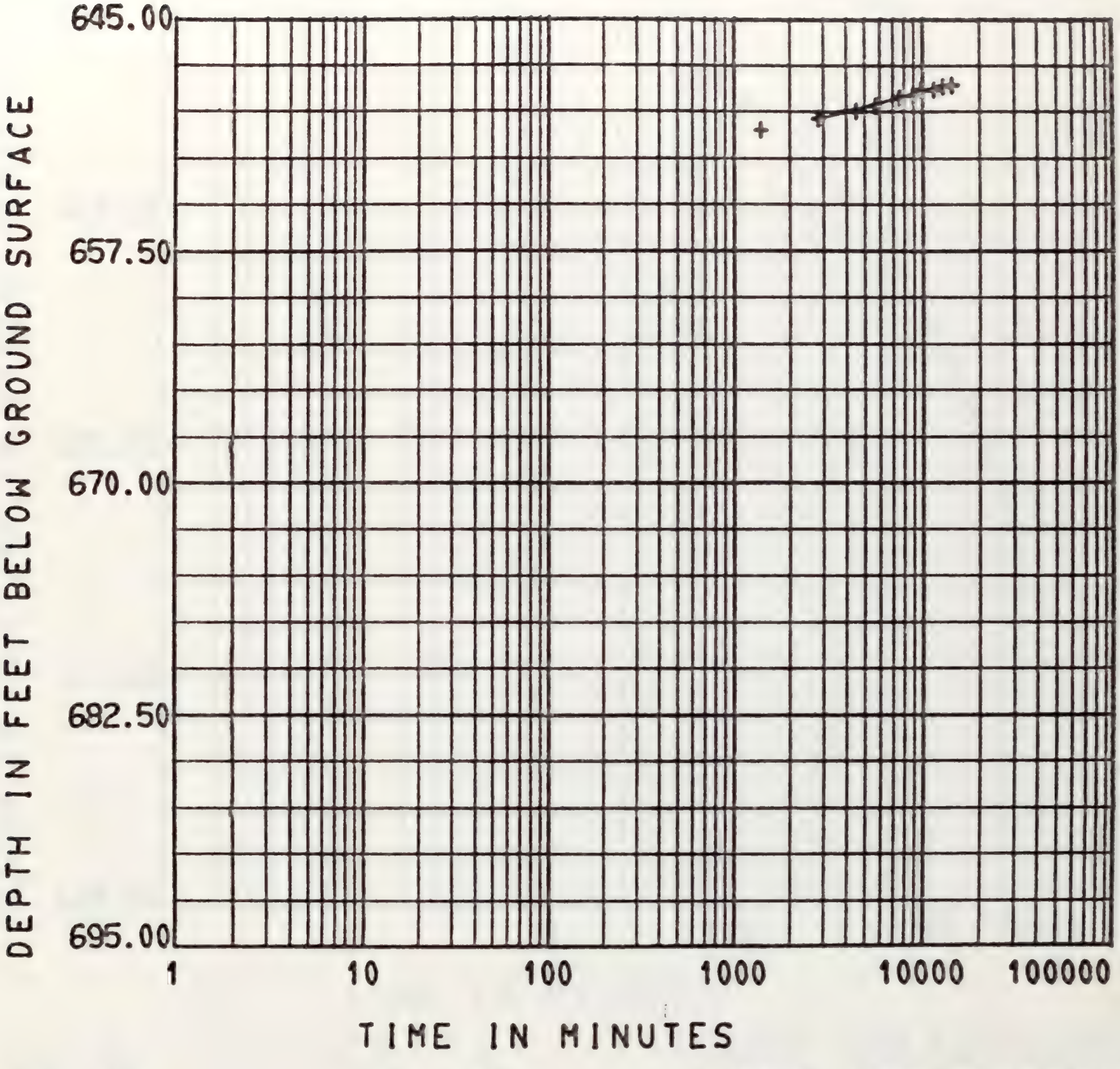
GS-8 GS-16 LOWR RECOVERY



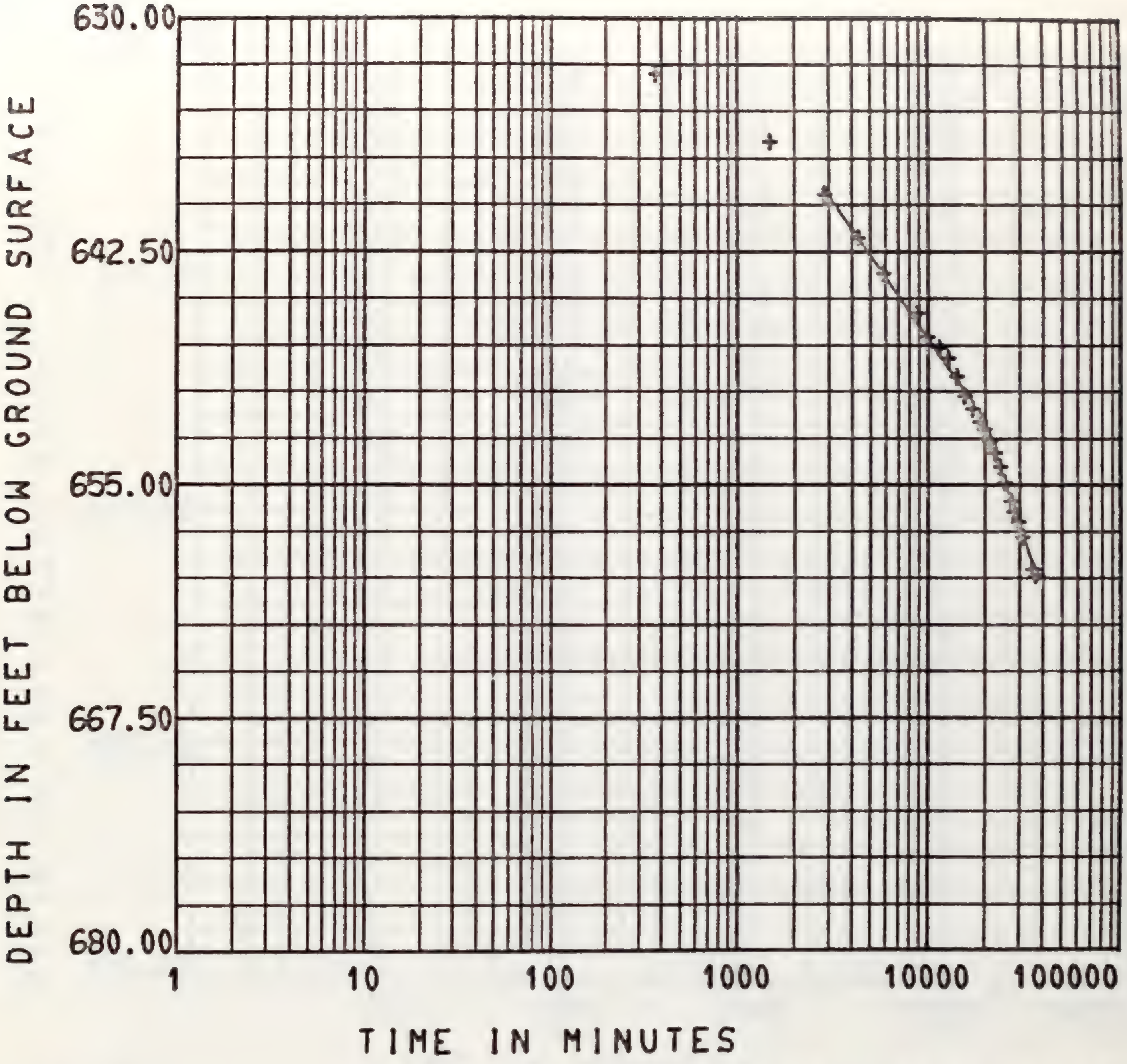
GS-8 GS-17 LOWR DRAWDOWN



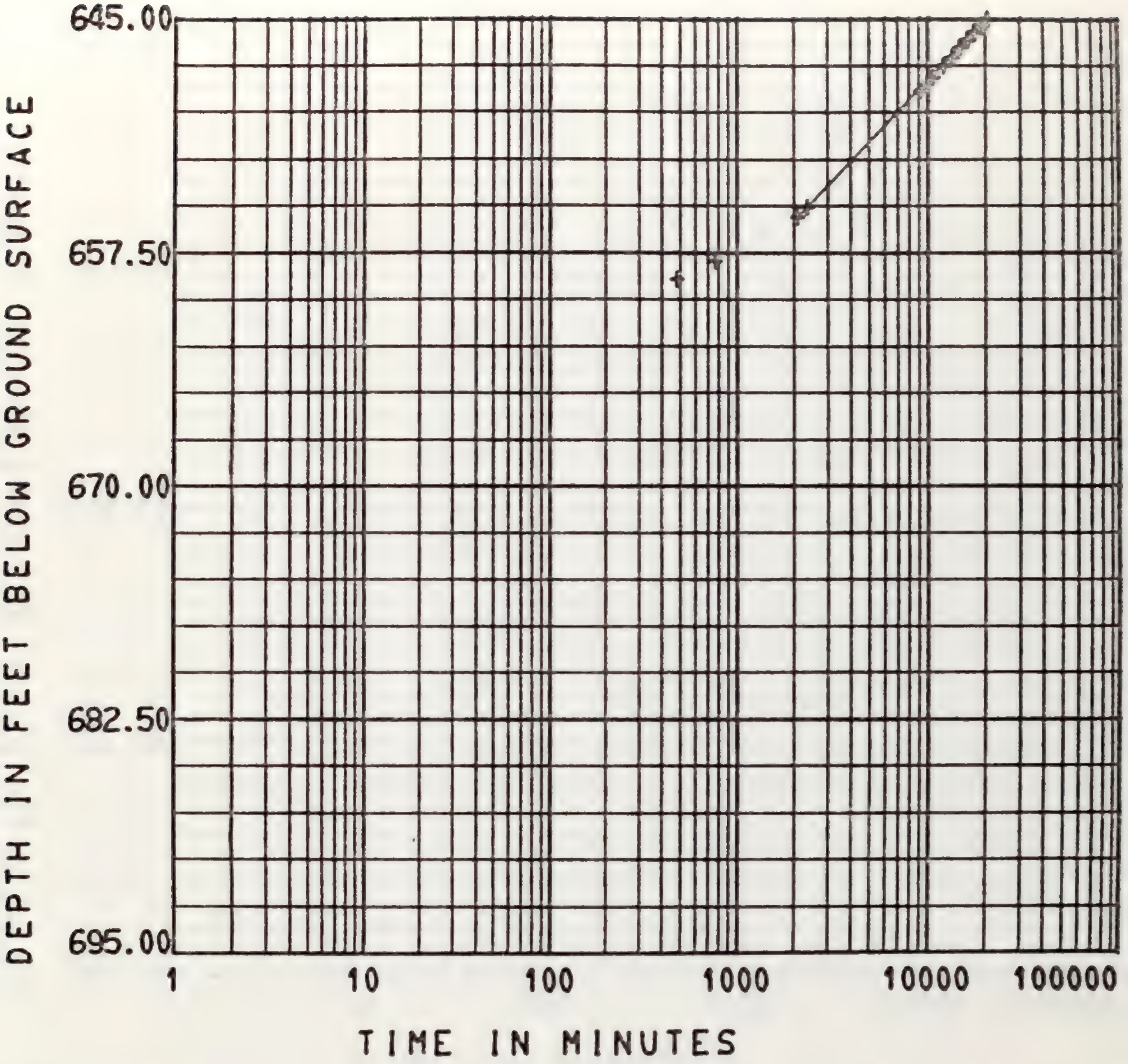
GS-8 GS-17 LOWR RECOVERY



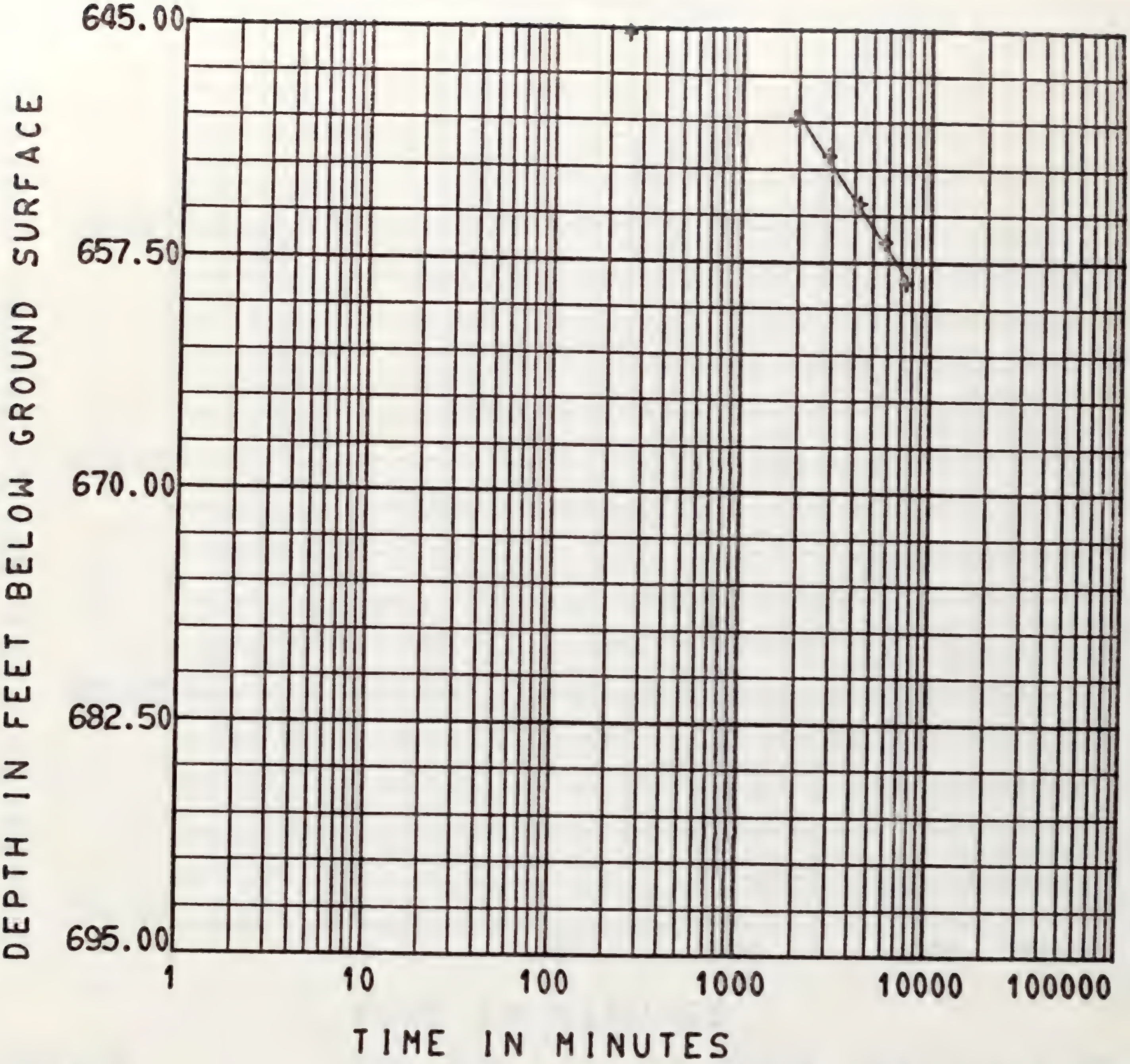
GS-8 GS-18 LOWR RECOVERY



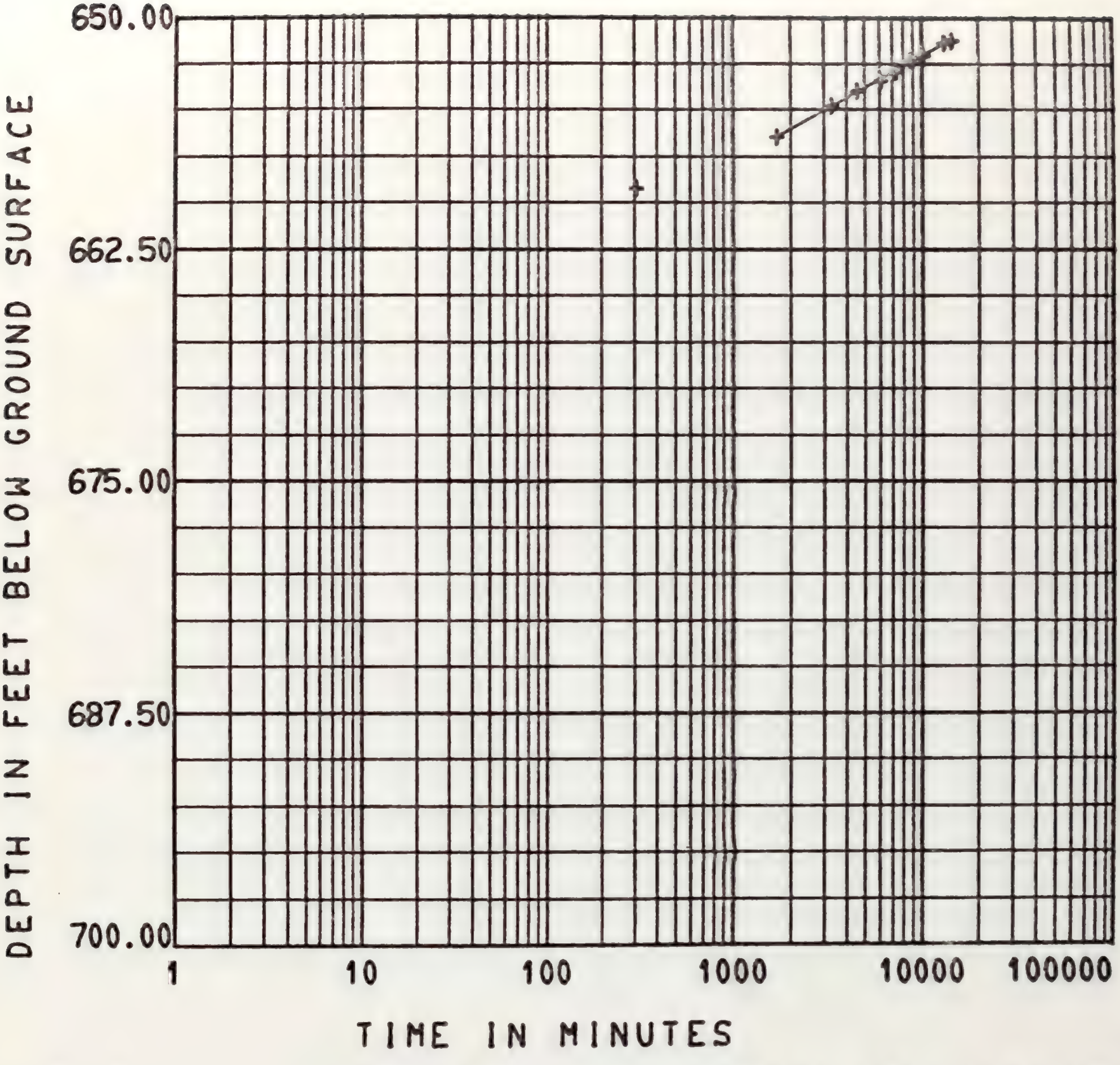
GS-8 GS-19 LOWR DRAWDOWN



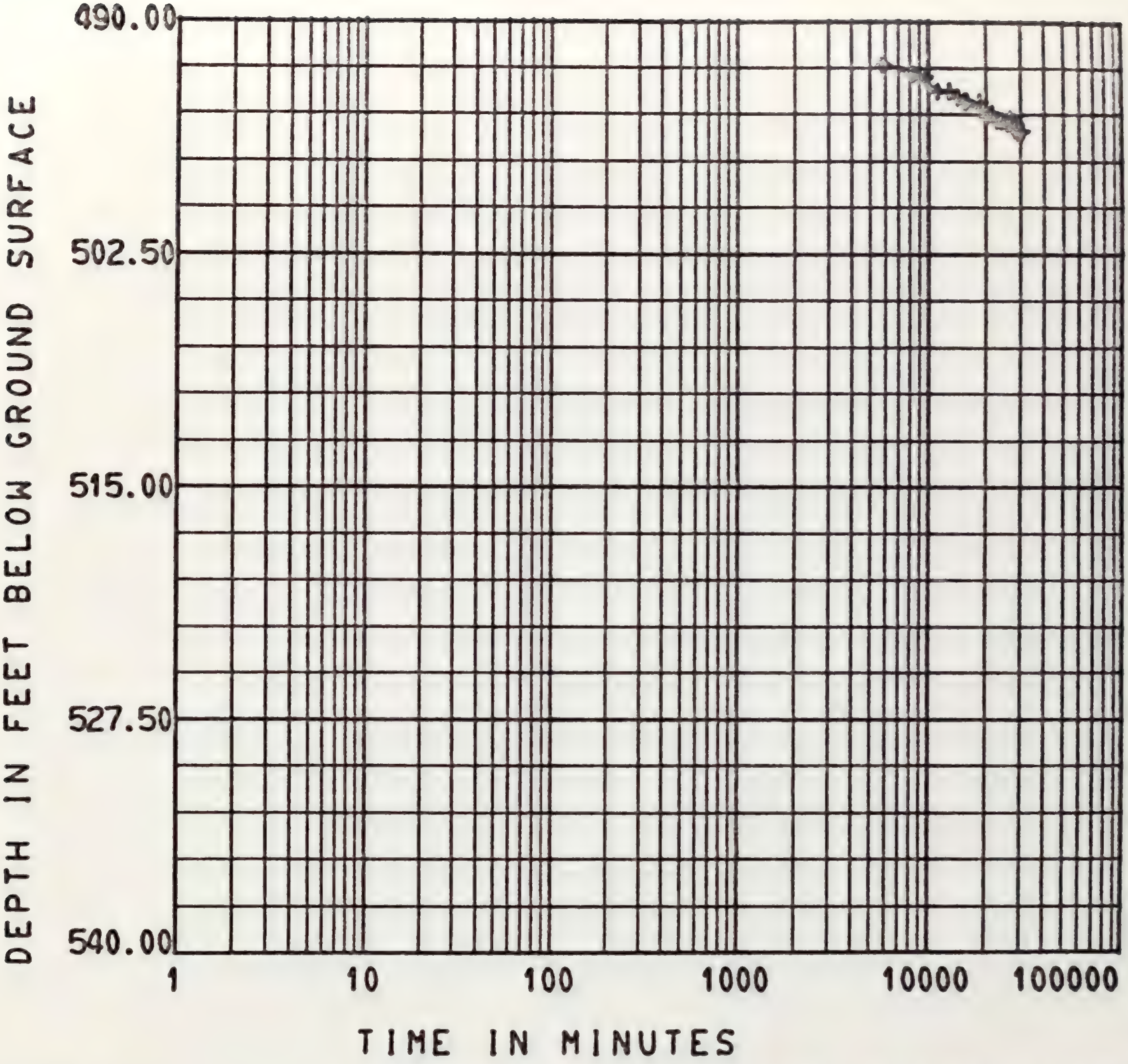
GS-8 GS-19 LOWR RECOVERY



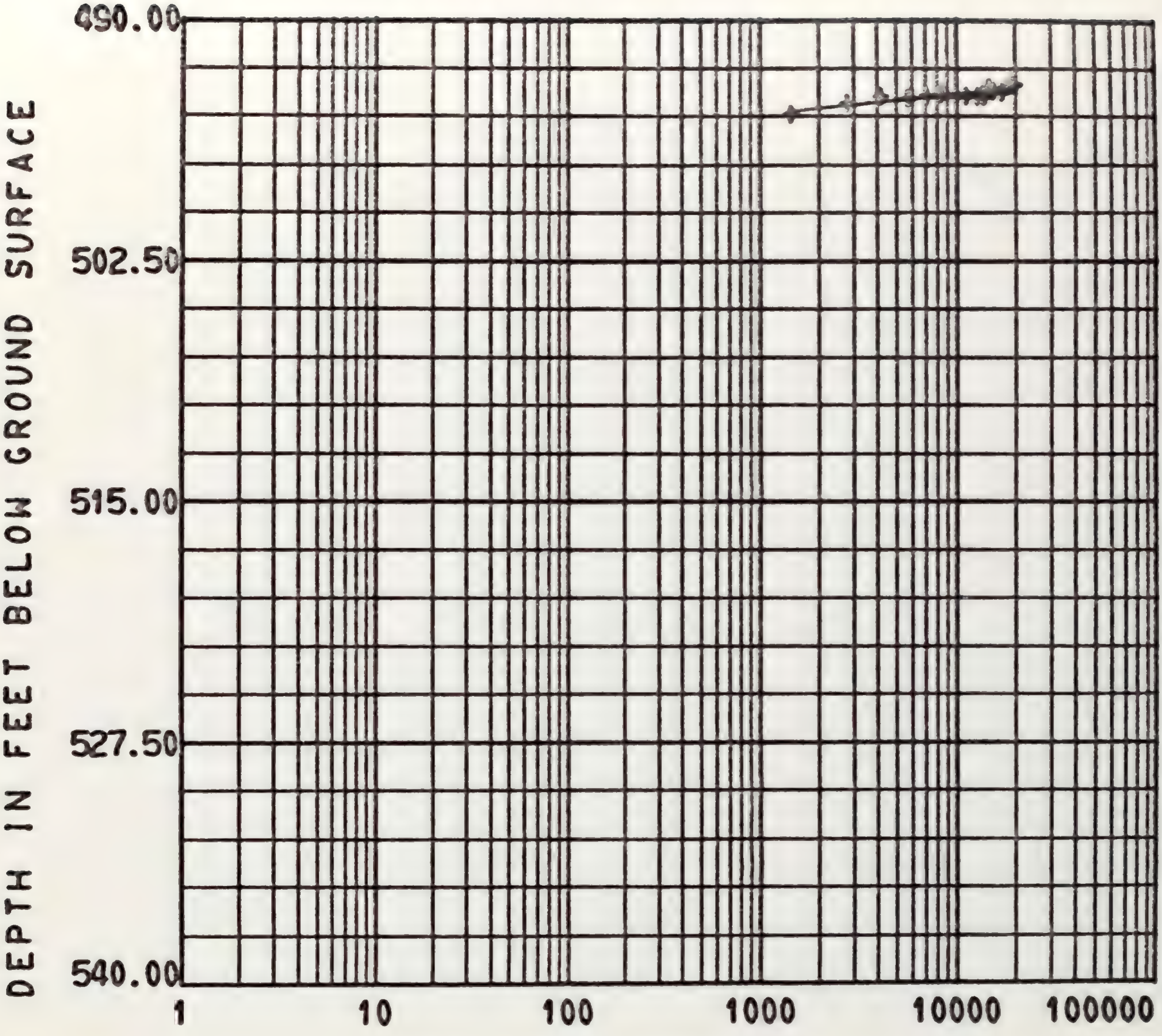
GS-8 GS-19 LOWR DRAWDOWN



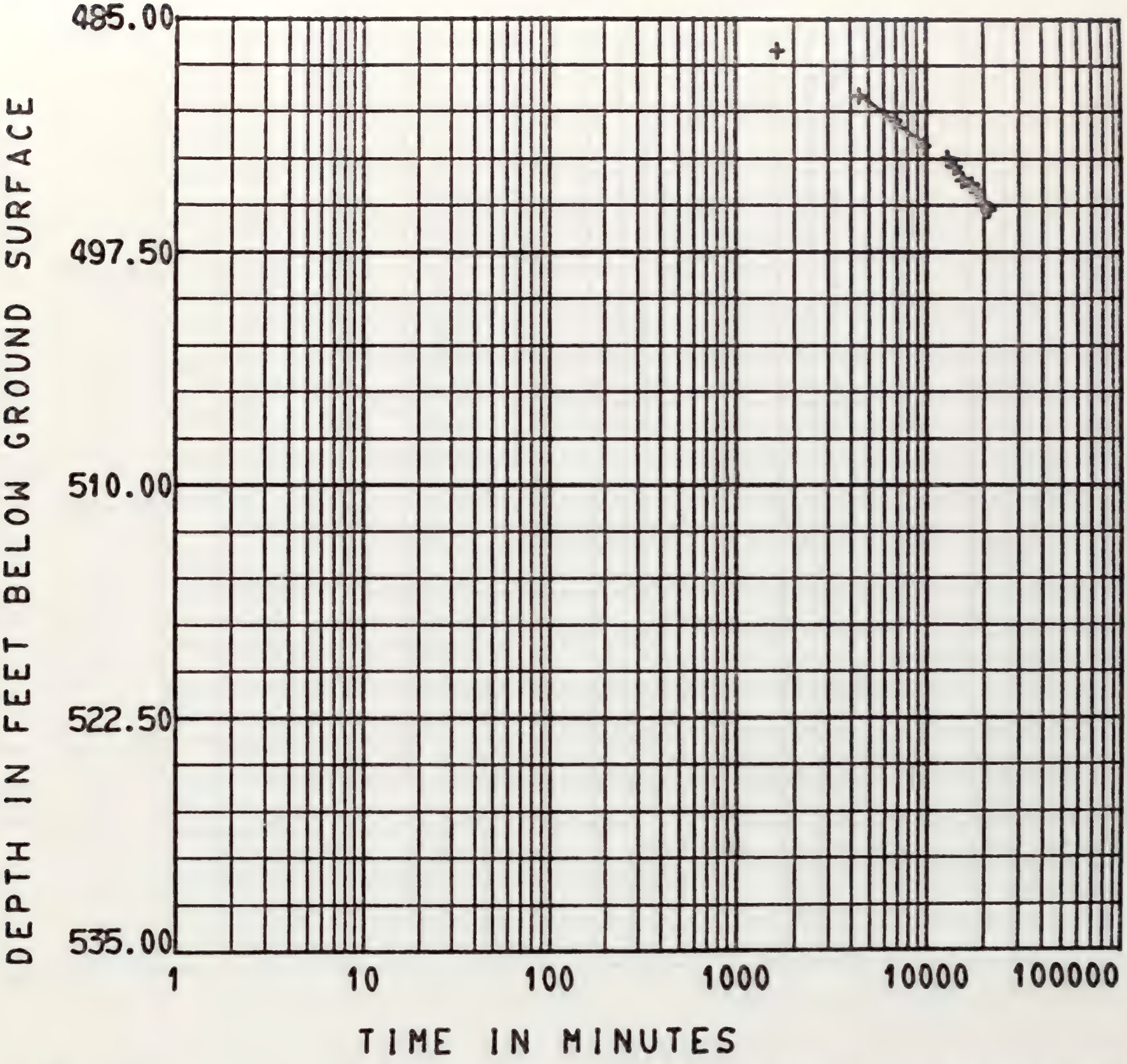
GS-8 GS-19 LOWR RECOVERY



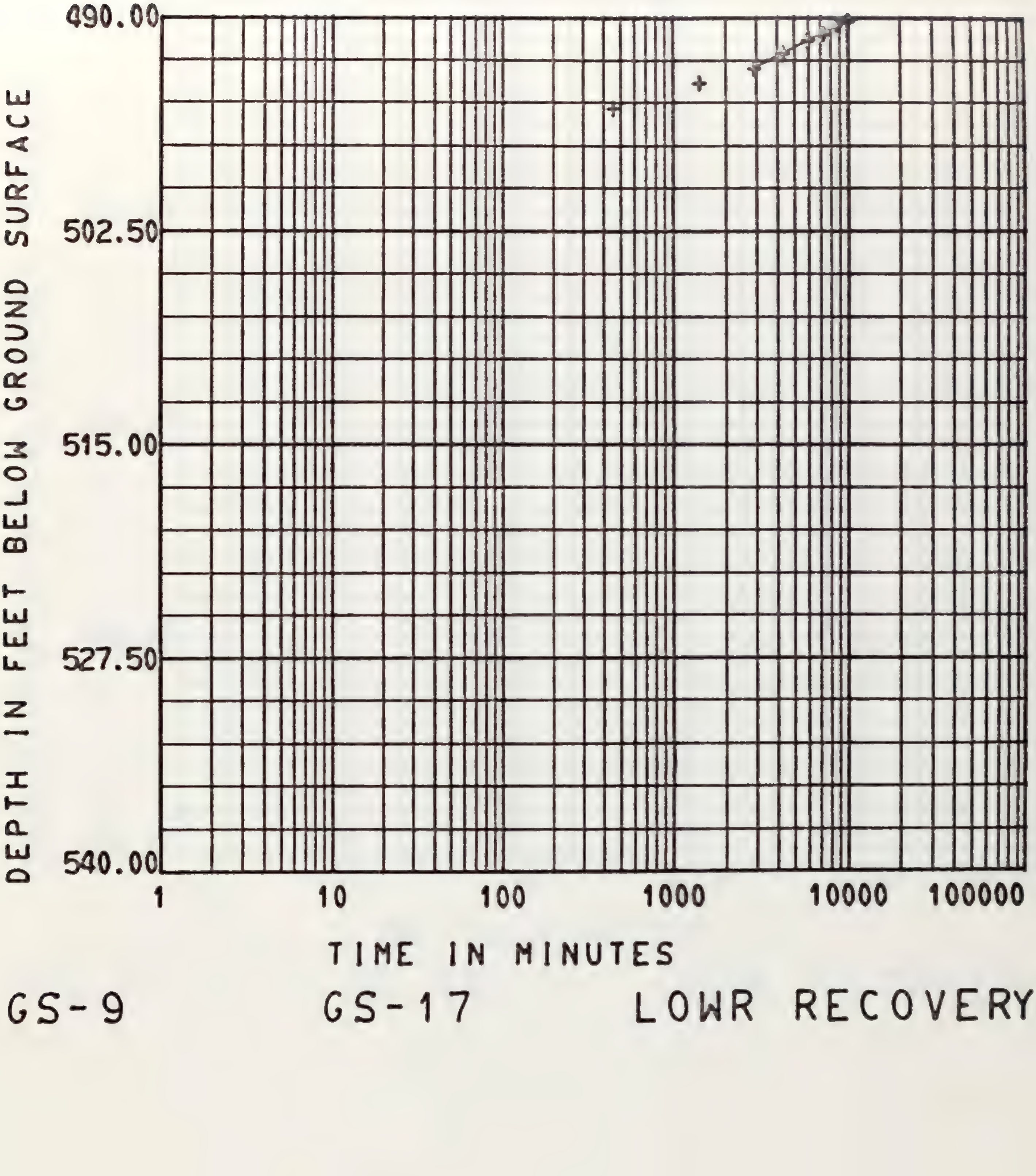
GS-9 GS-16 LOWR DRAWDOWN



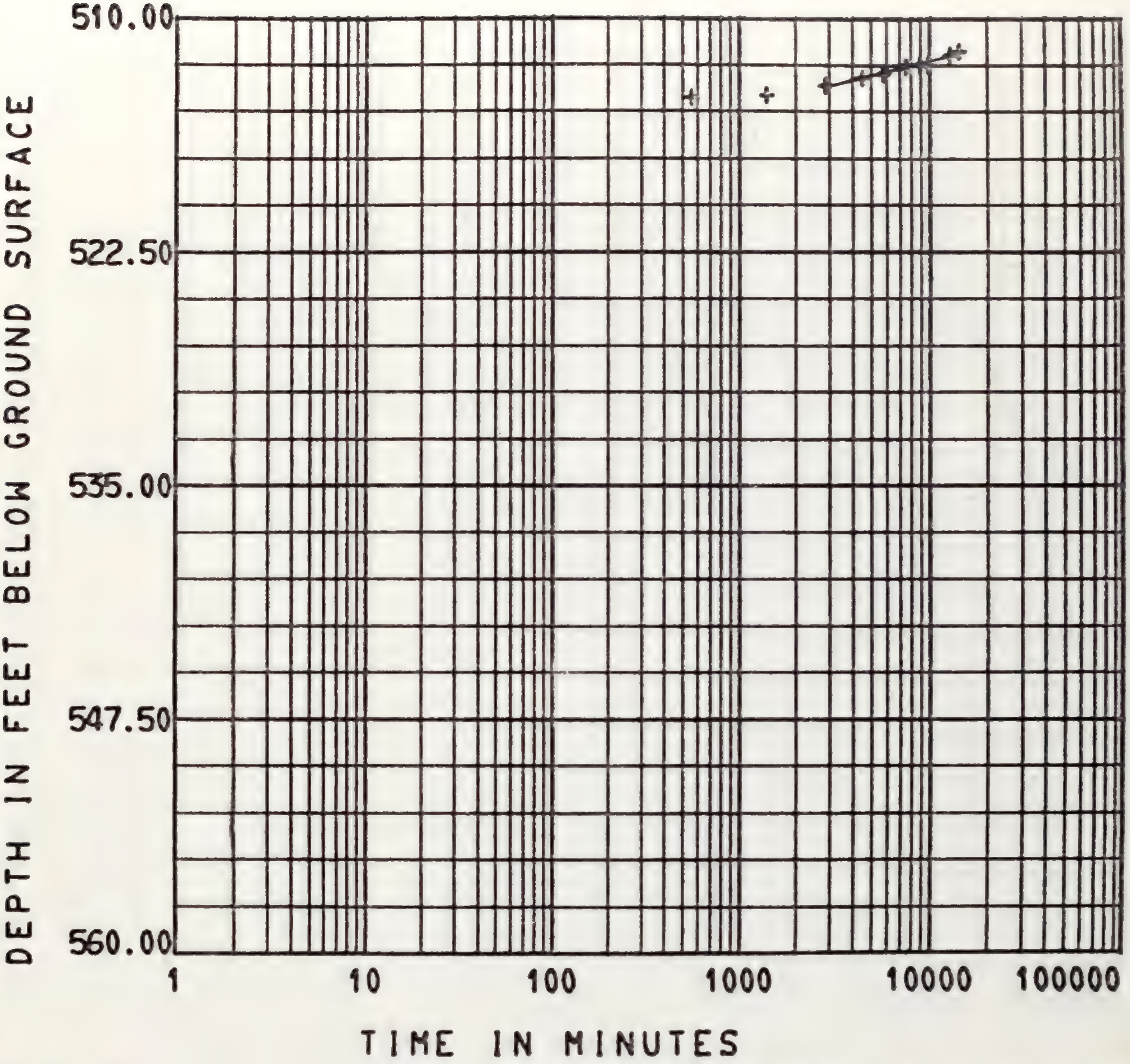
GS-9 GS-16 LOWR RECOVERY



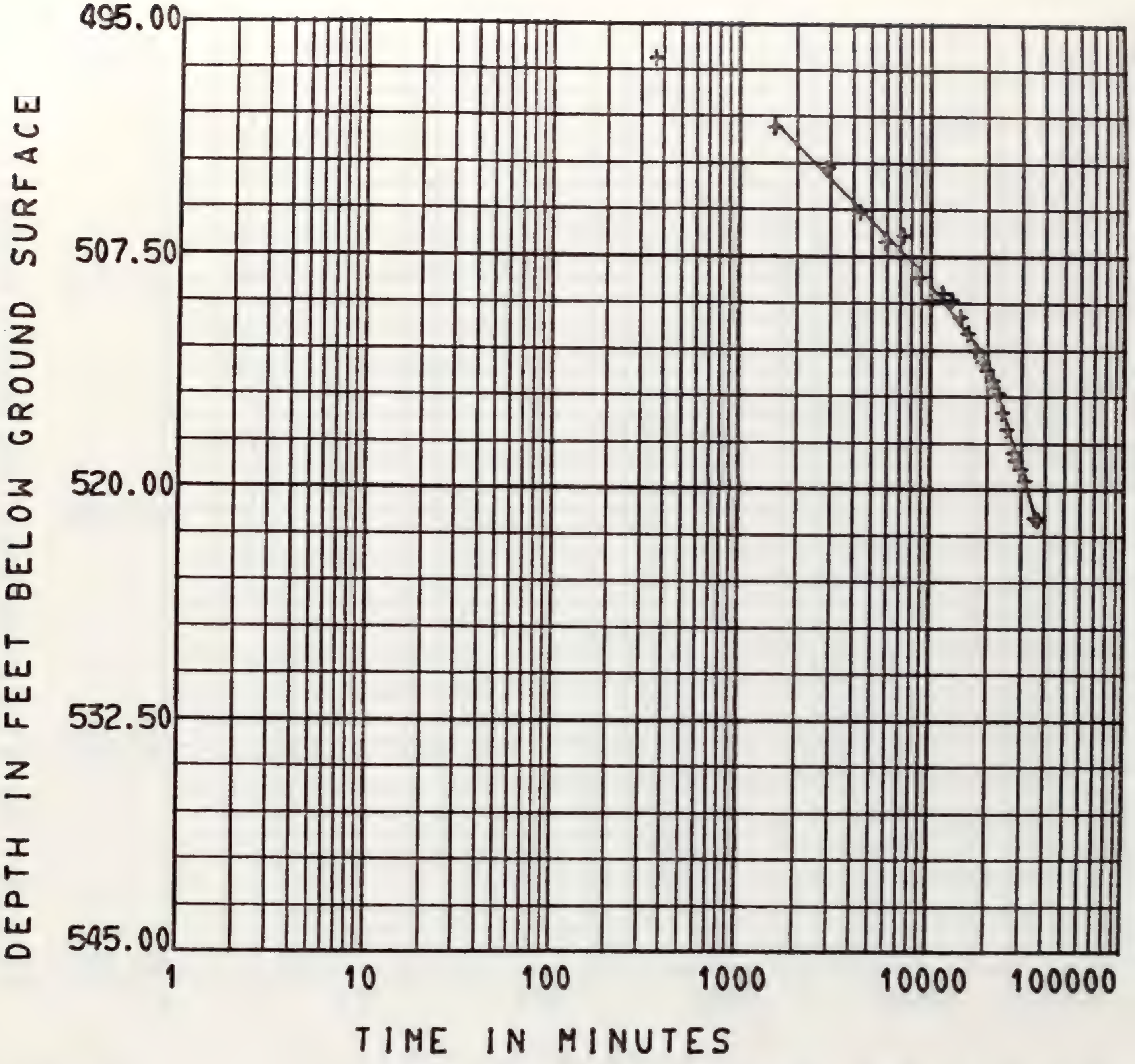
GS-9 GS-17 LOWR DRAWDOWN



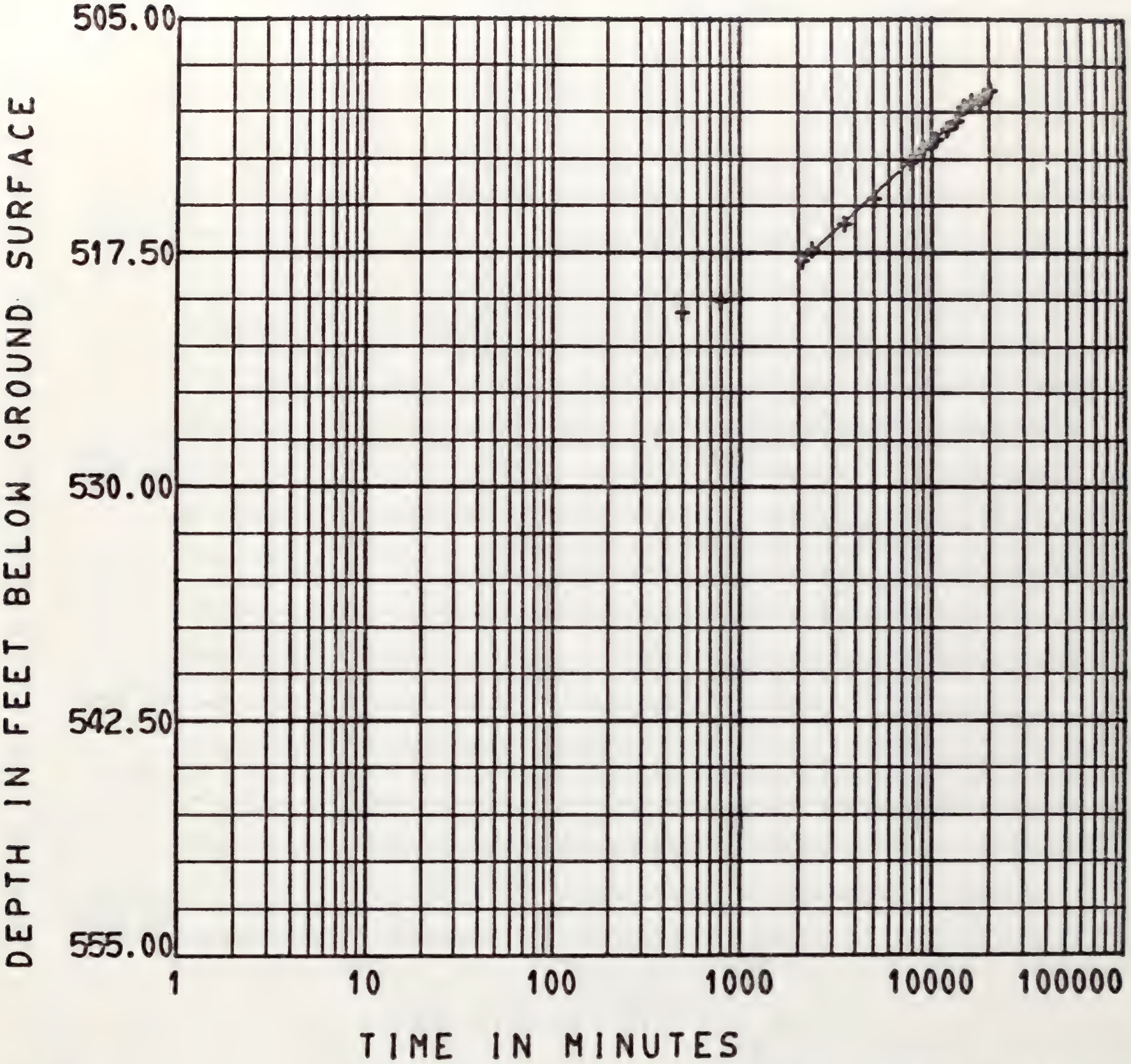
GS-9 GS-17 LOWR RECOVERY



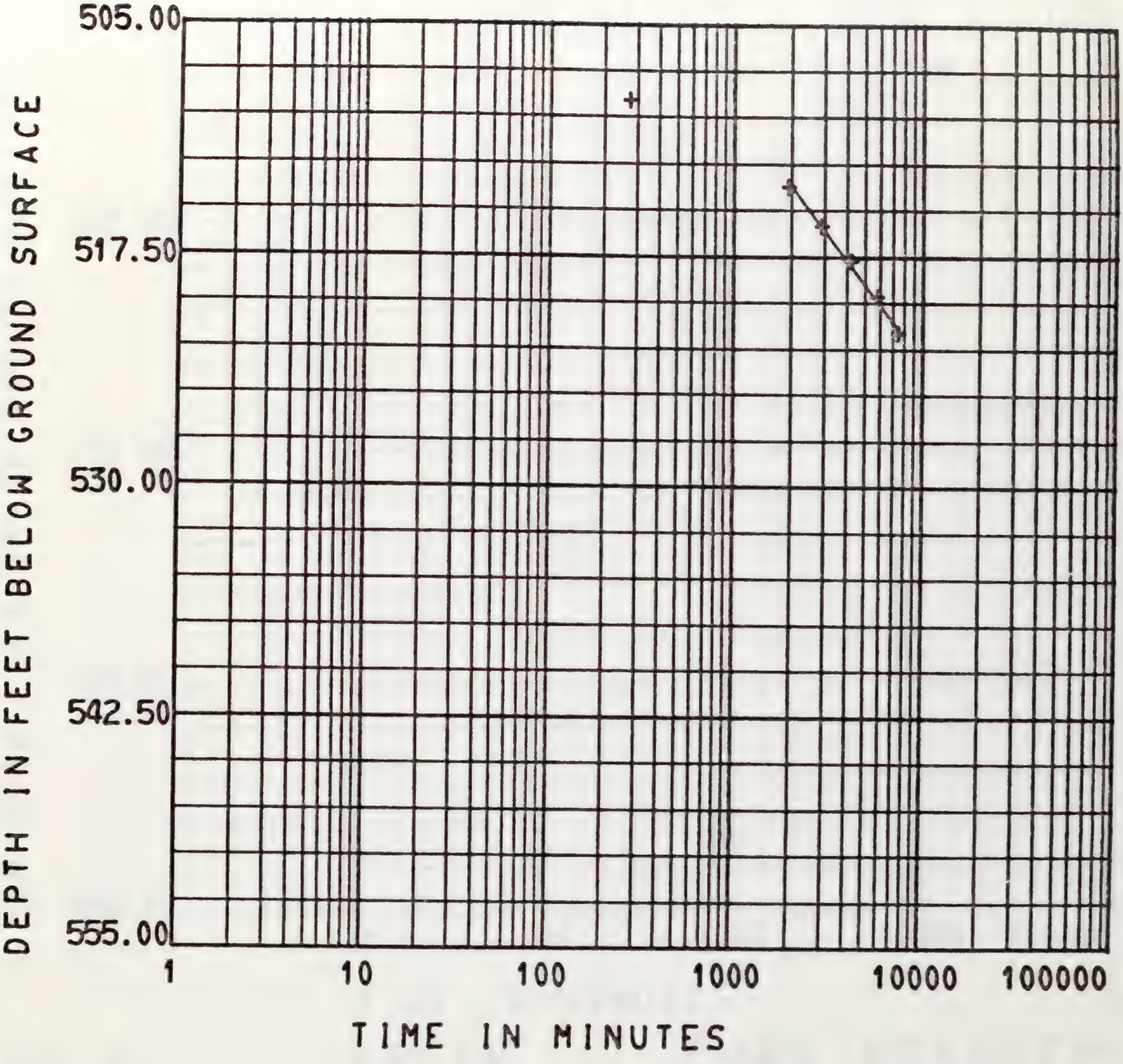
GS-9 GS-18 LOWR RECOVERY



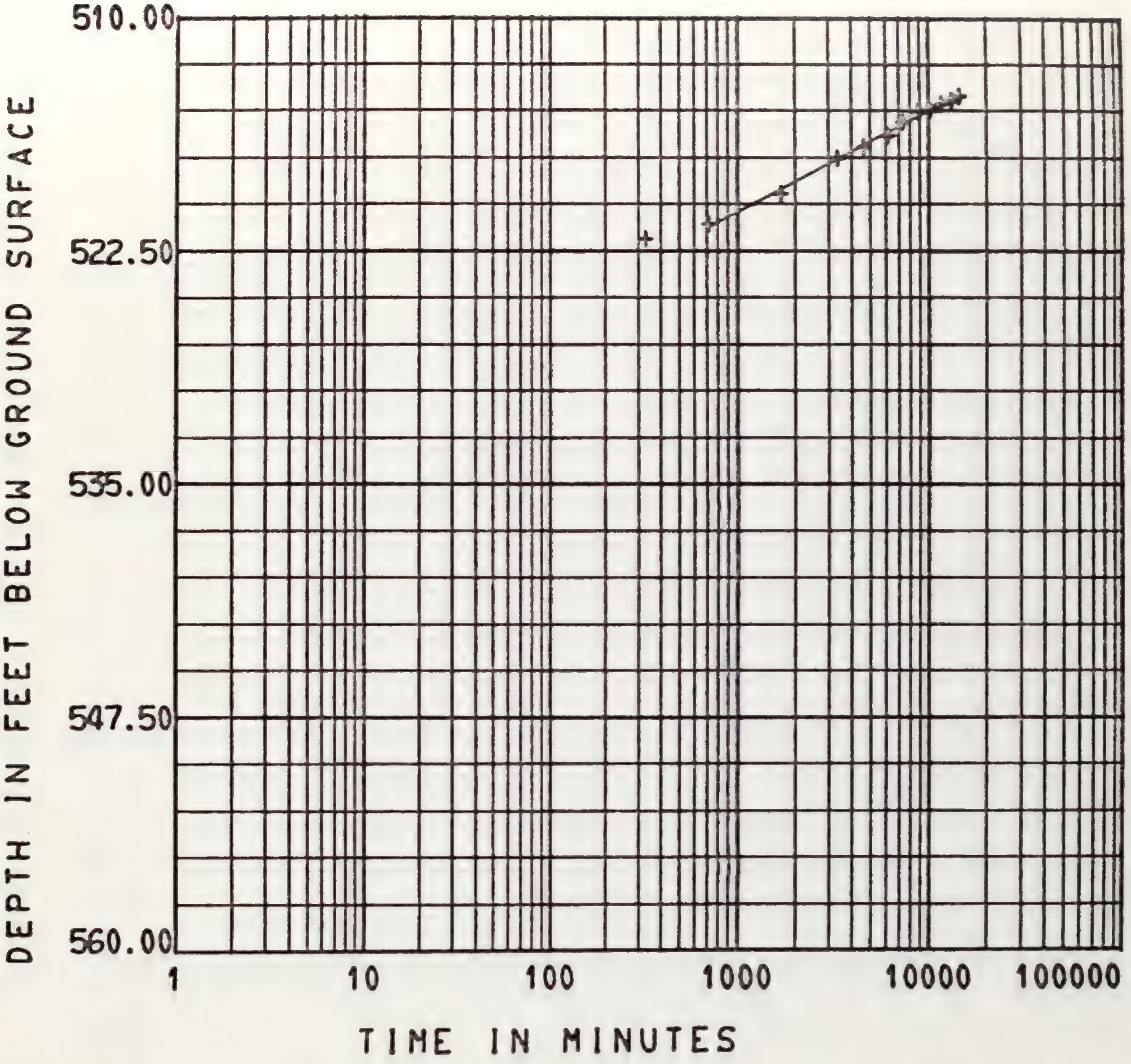
GS-9 GS-19 LOWR DRAWDOWN



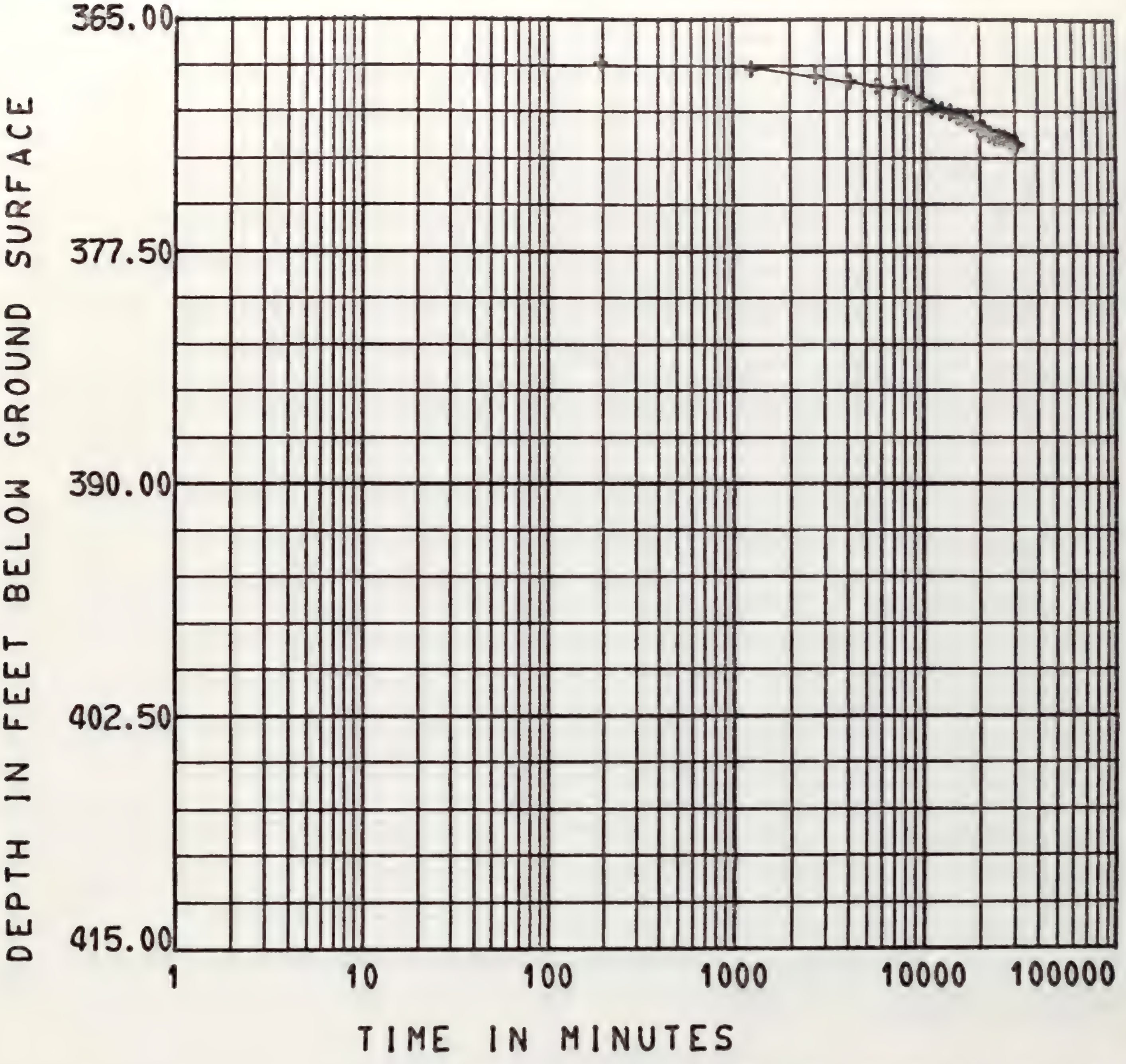
GS-9 GS-19 LOWR RECOVERY



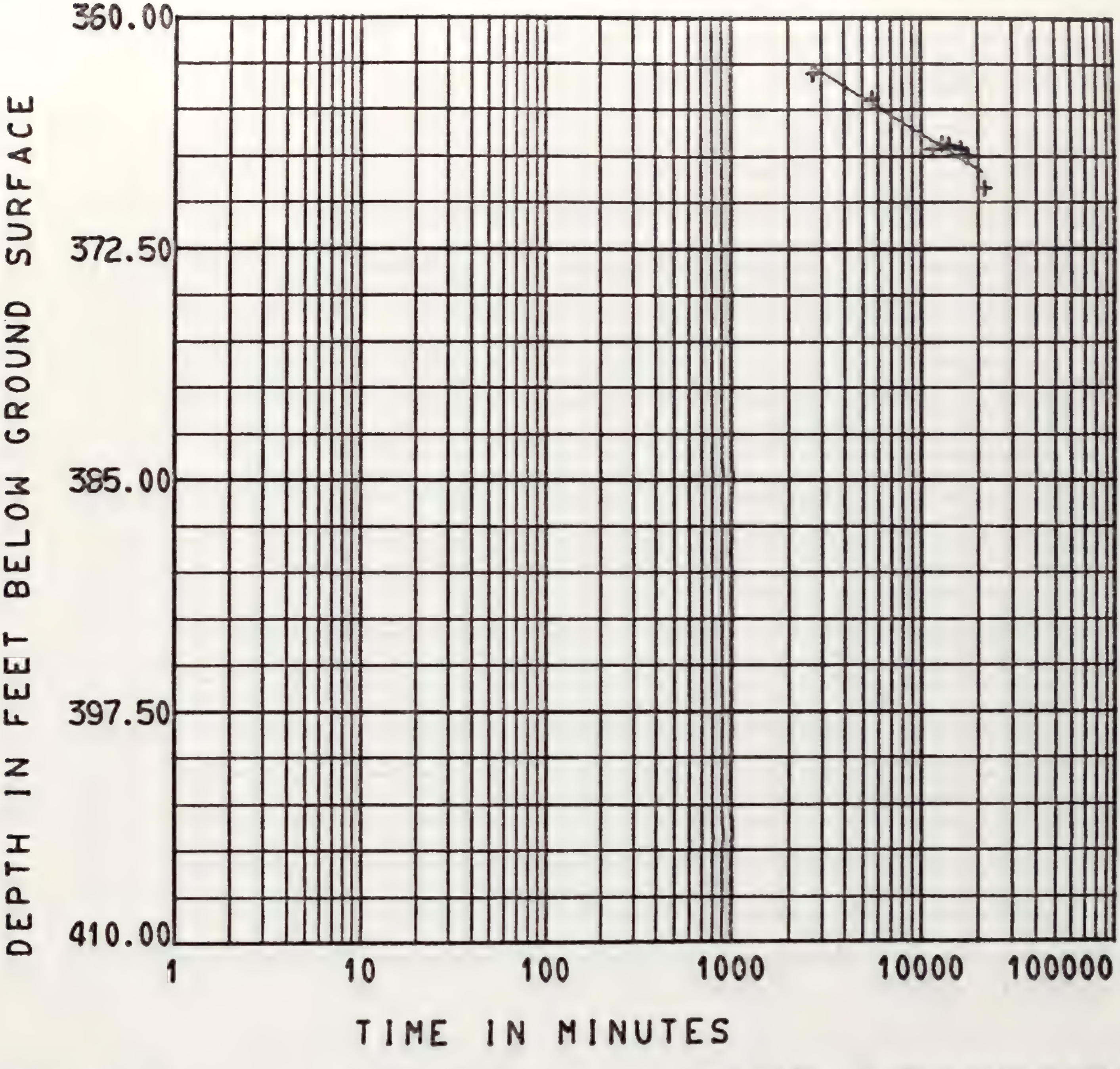
GS-9 GS-19 LOWR DRAWDOWN



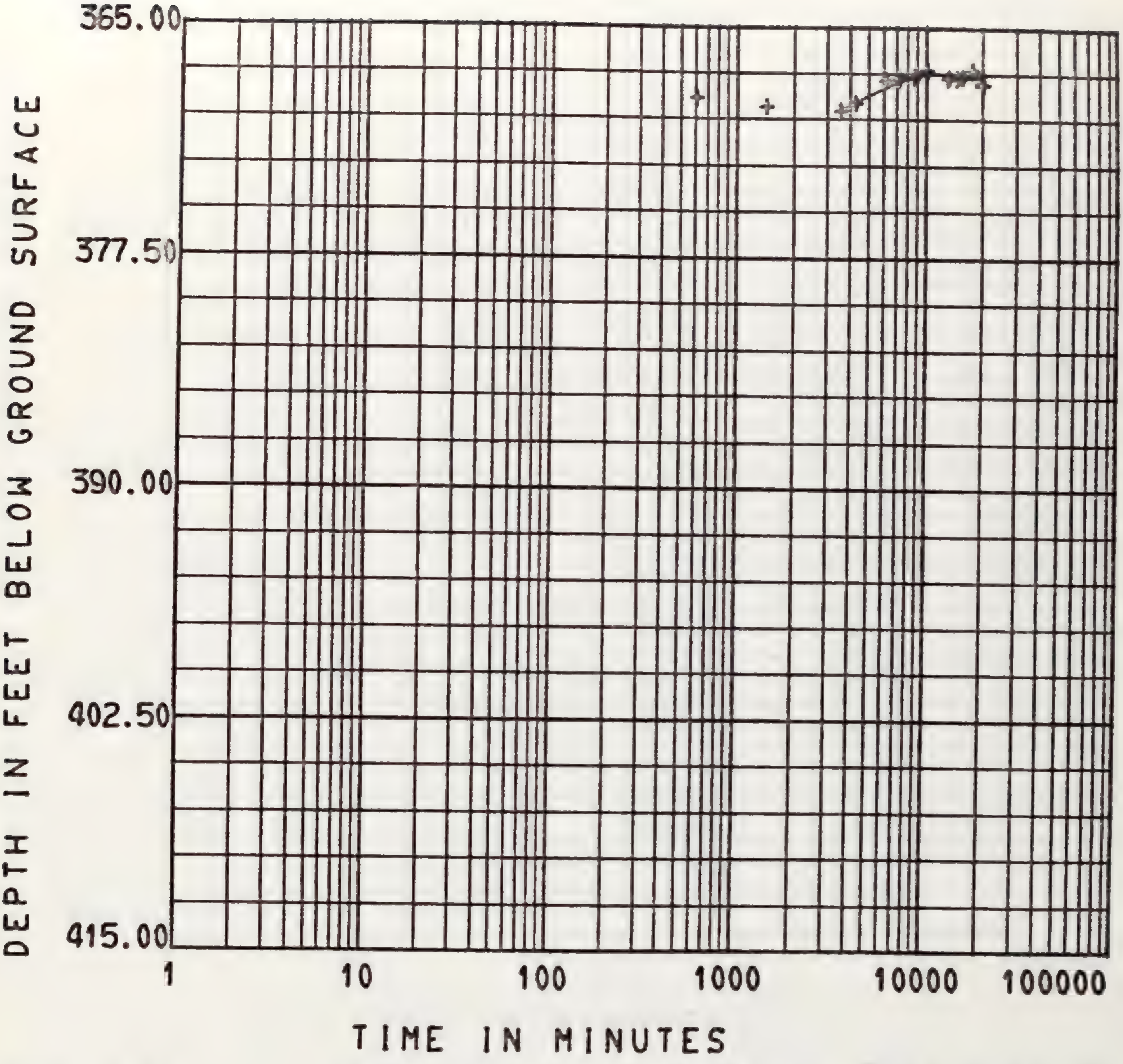
GS-9 GS-19 LOWR RECOVERY



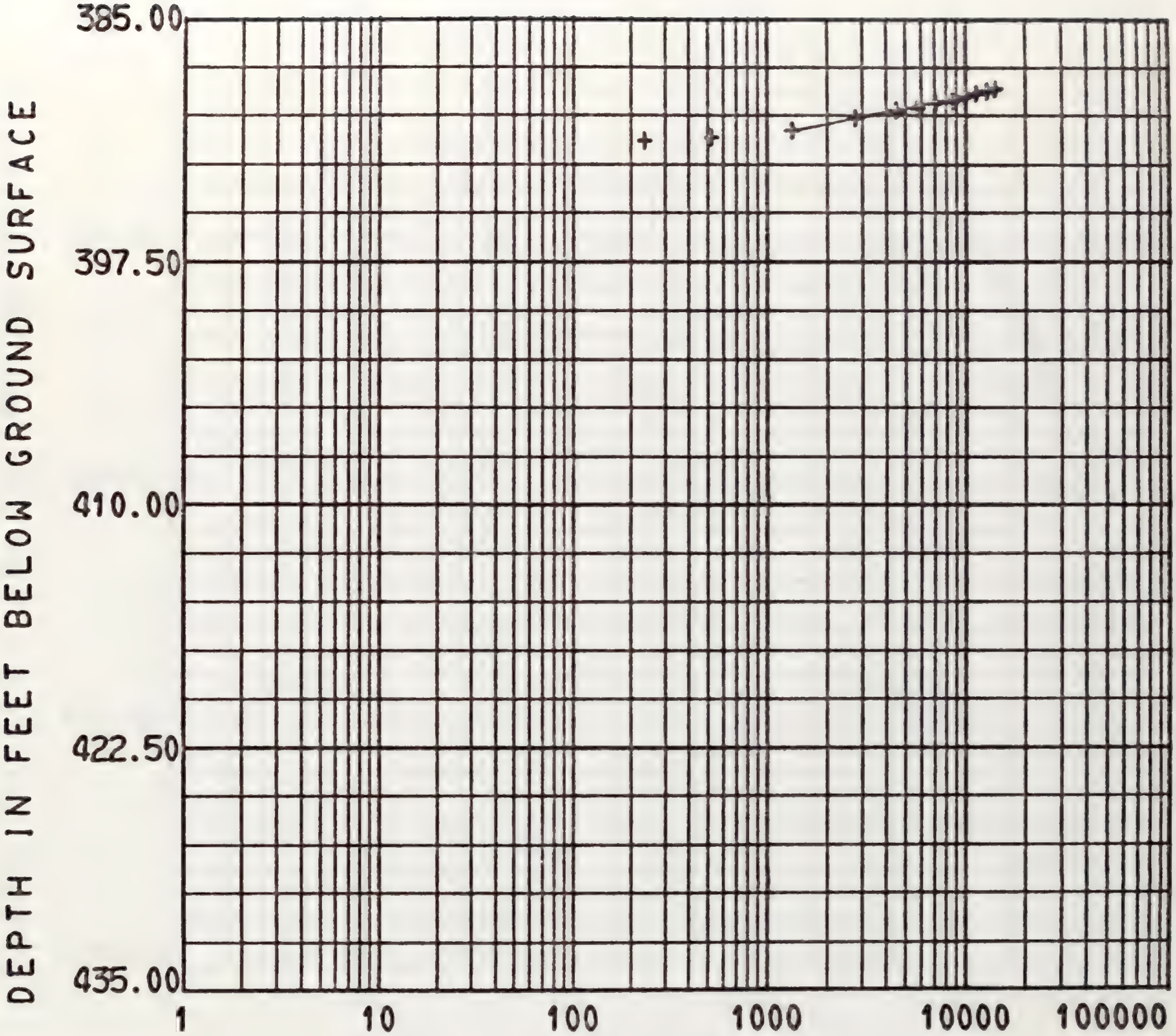
GS-10 GS-16 LOWR DRAWDOWN



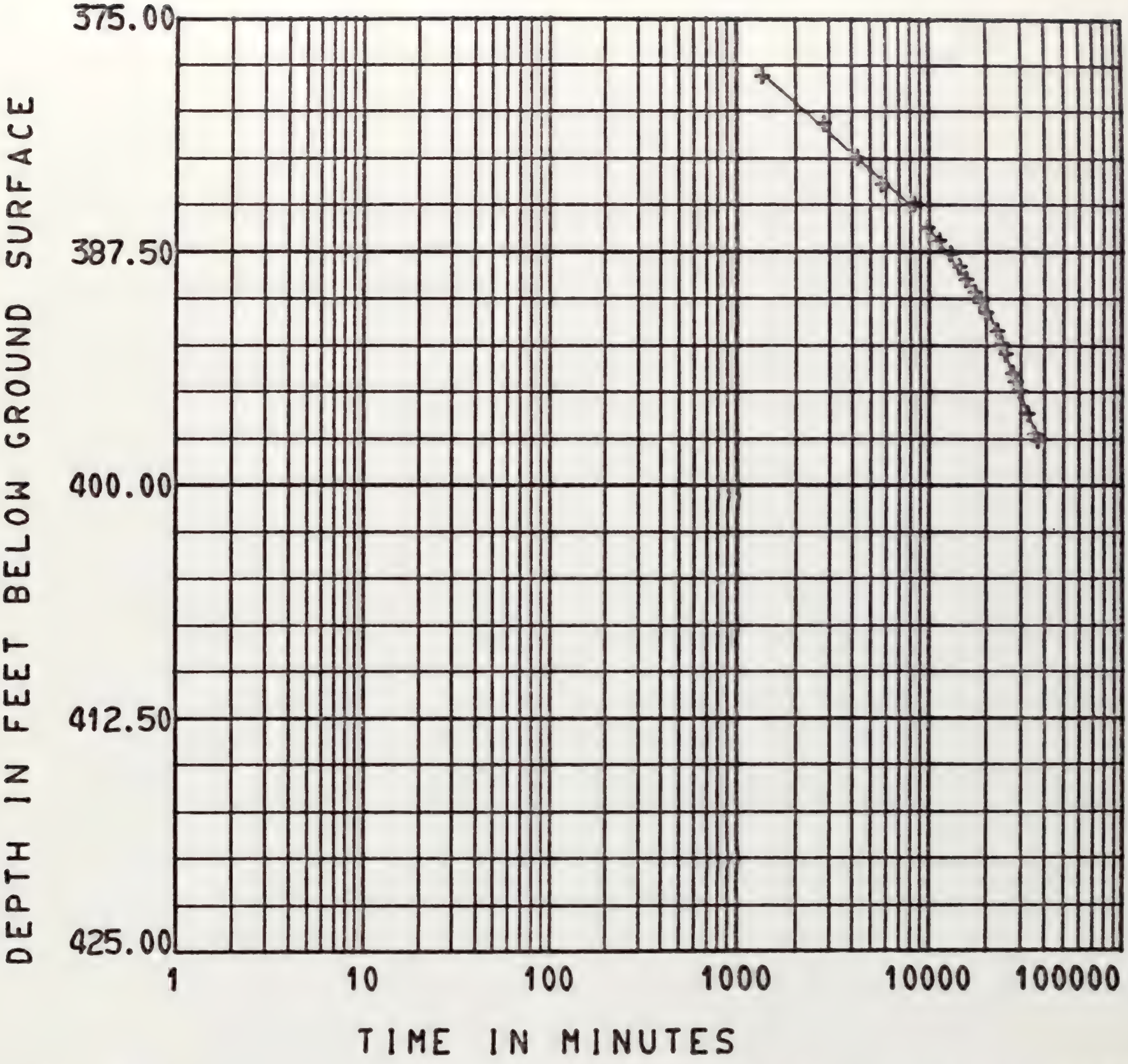
GS-10 GS-17 LOWR DRAWDOWN



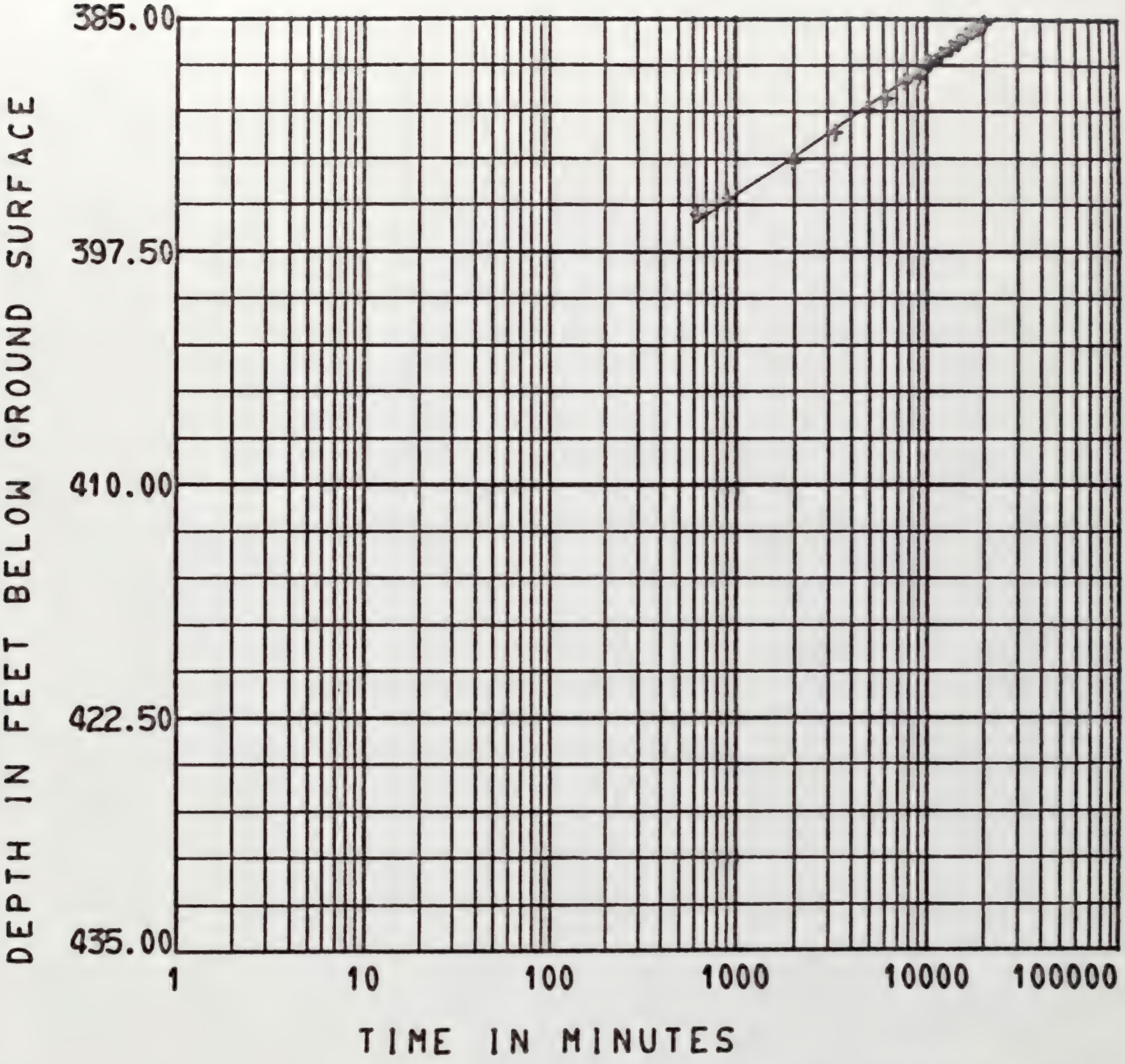
GS-10 GS-17 LOWR RECOVERY



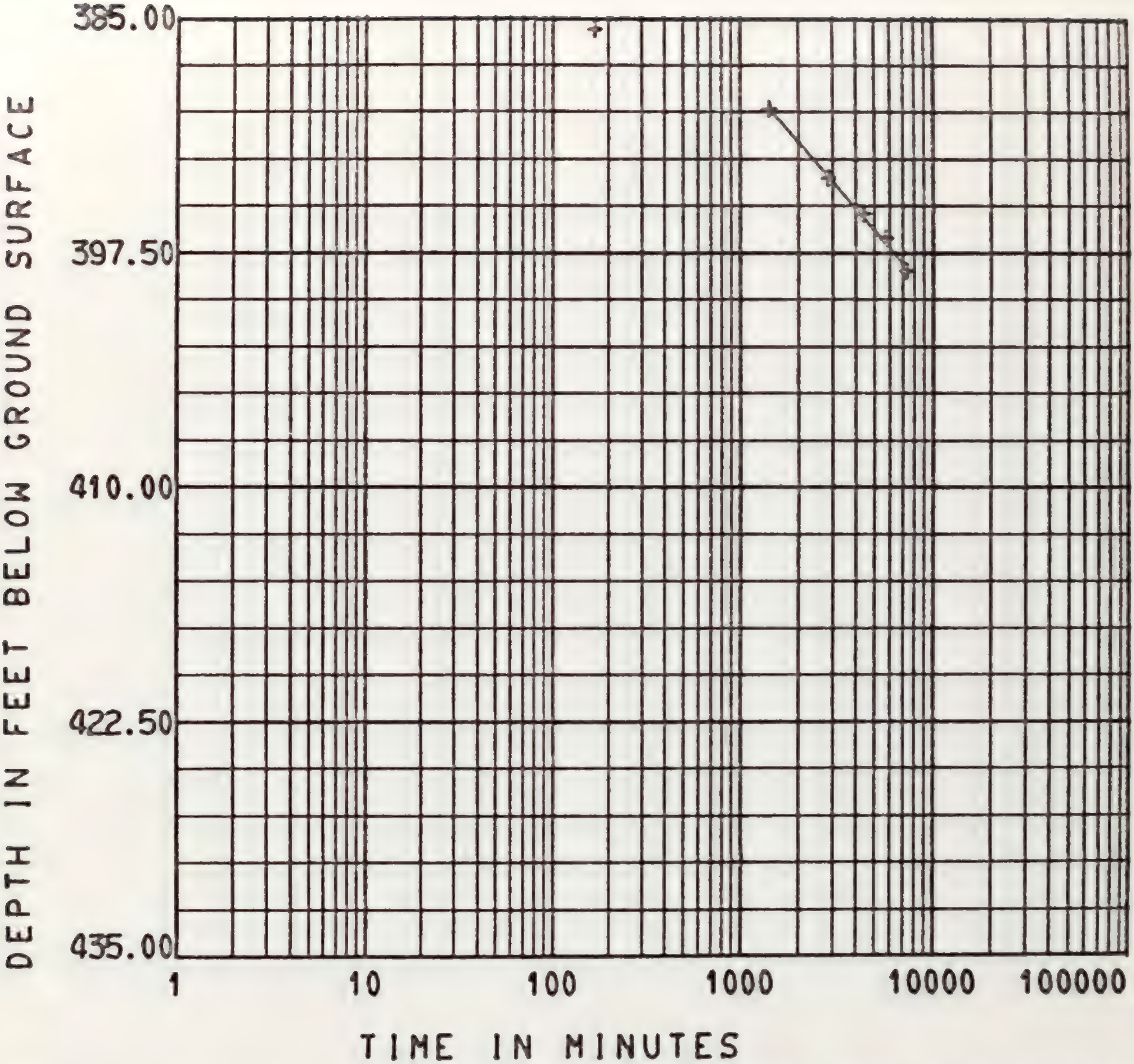
GS-10 GS-18 LOWR RECOVERY



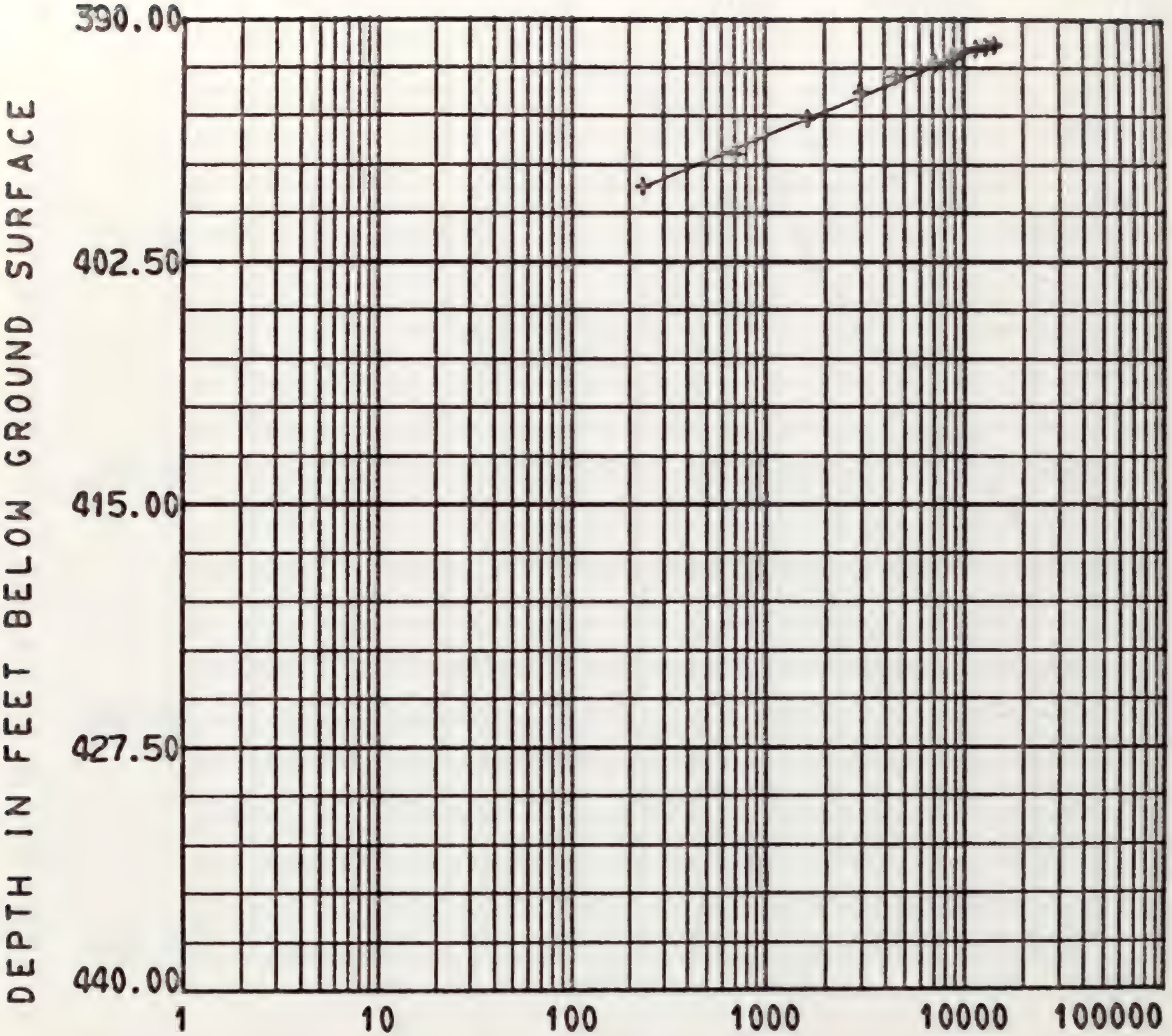
GS-10 GS-19 LOWR DRAWDOWN



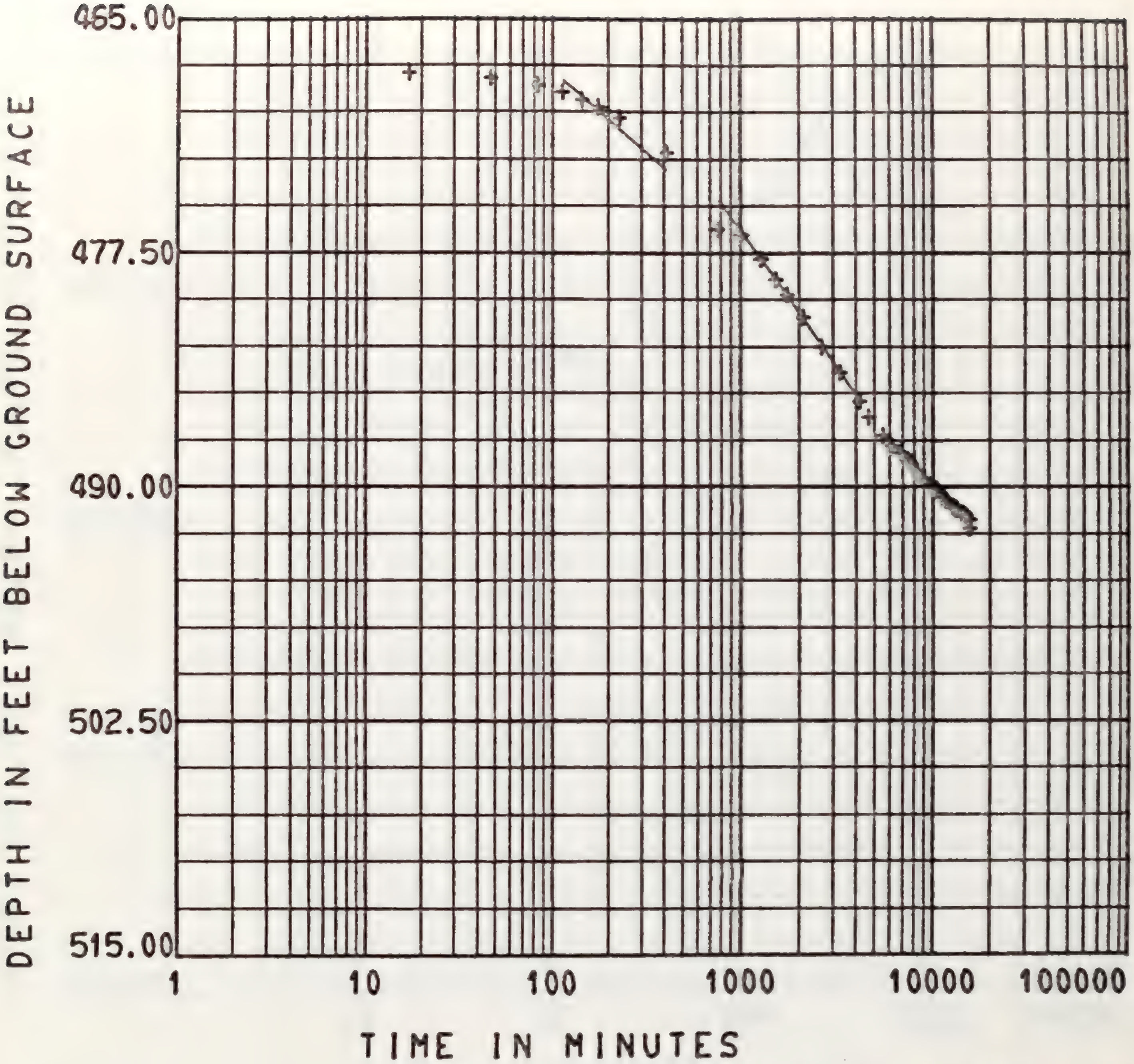
GS-10 GS-19 LOWR RECOVERY



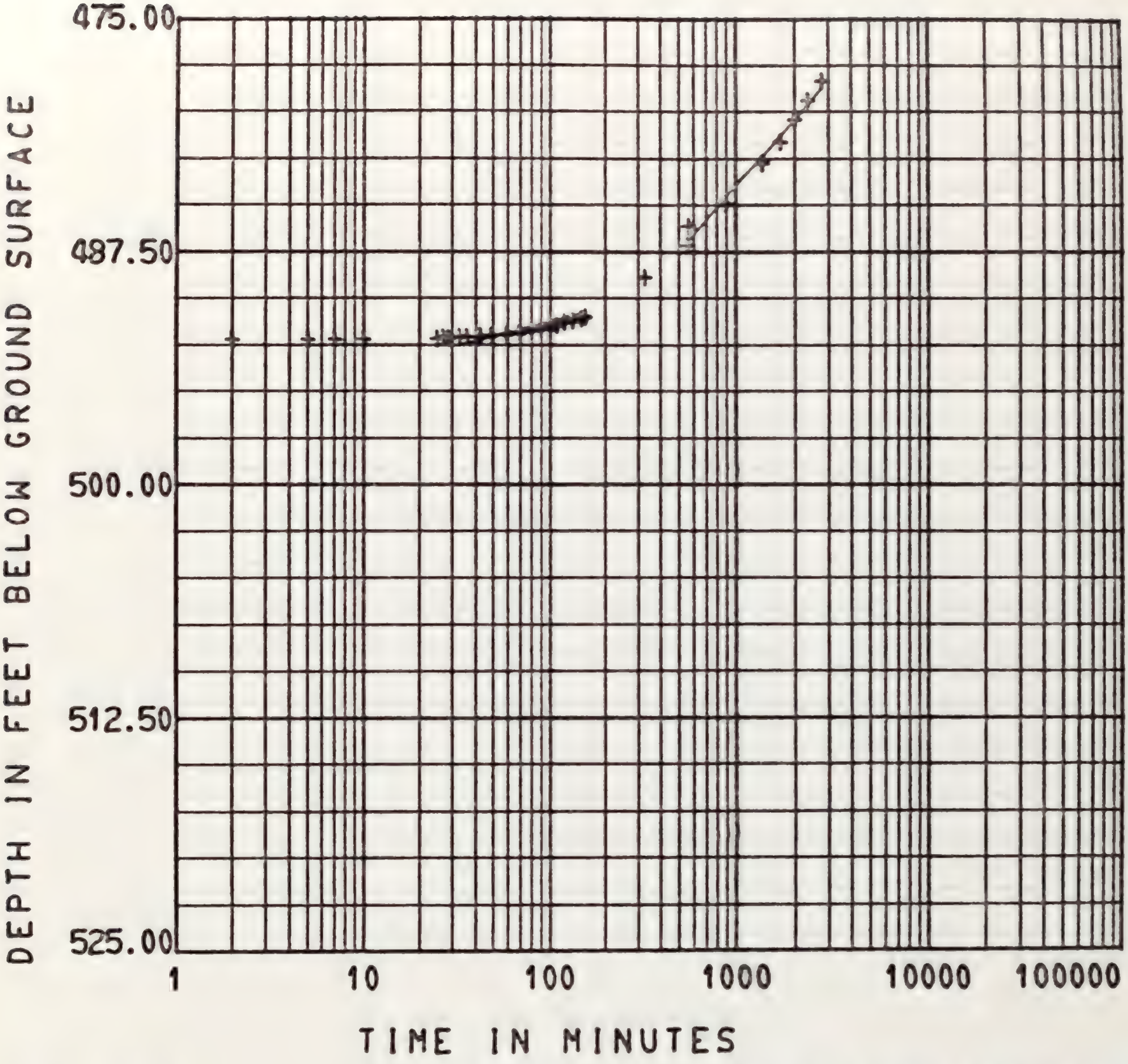
GS-10 GS-19 LOWR DRAWDOWN



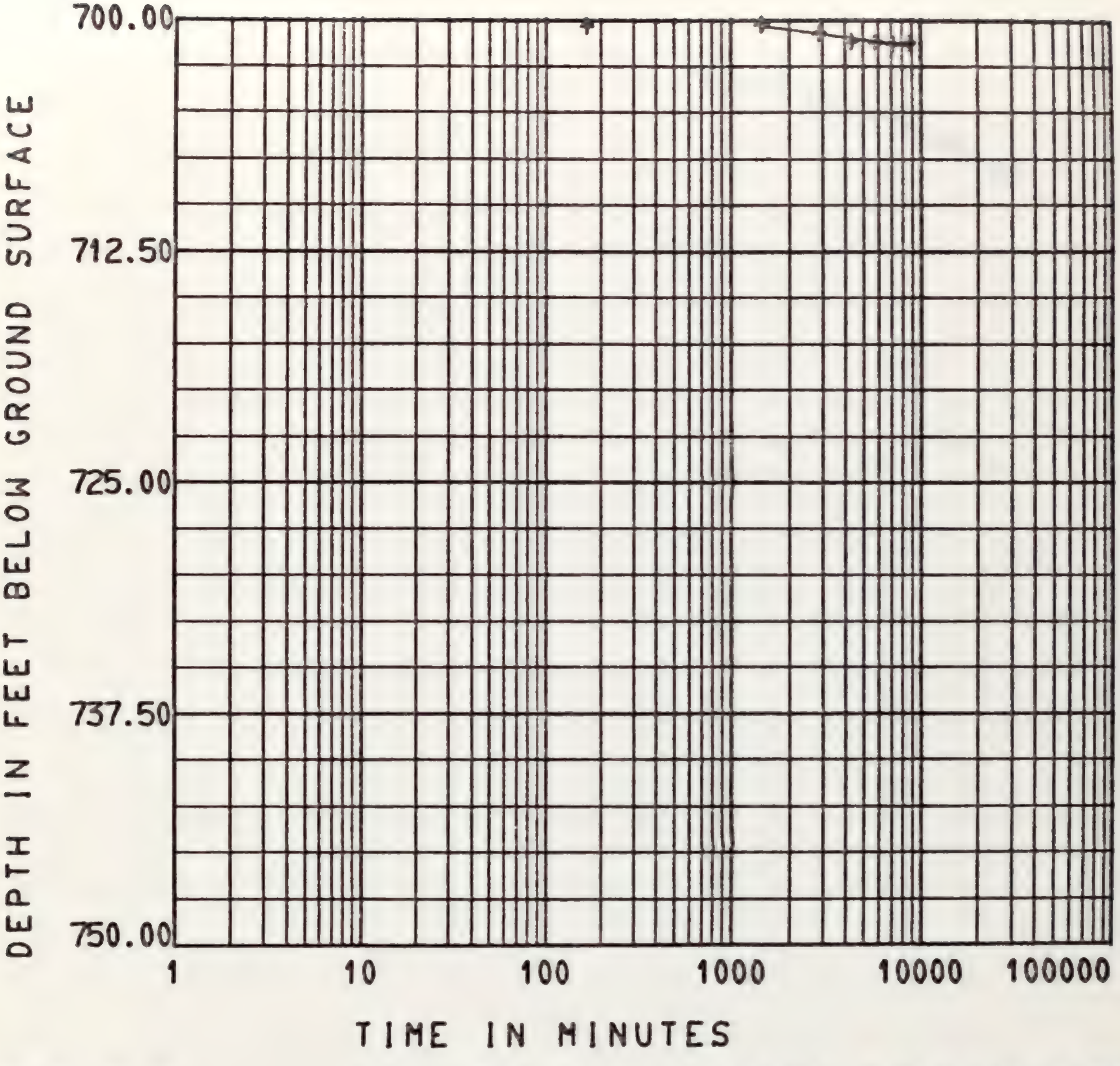
GS-10 GS-19 LOWR DRAWDOWN



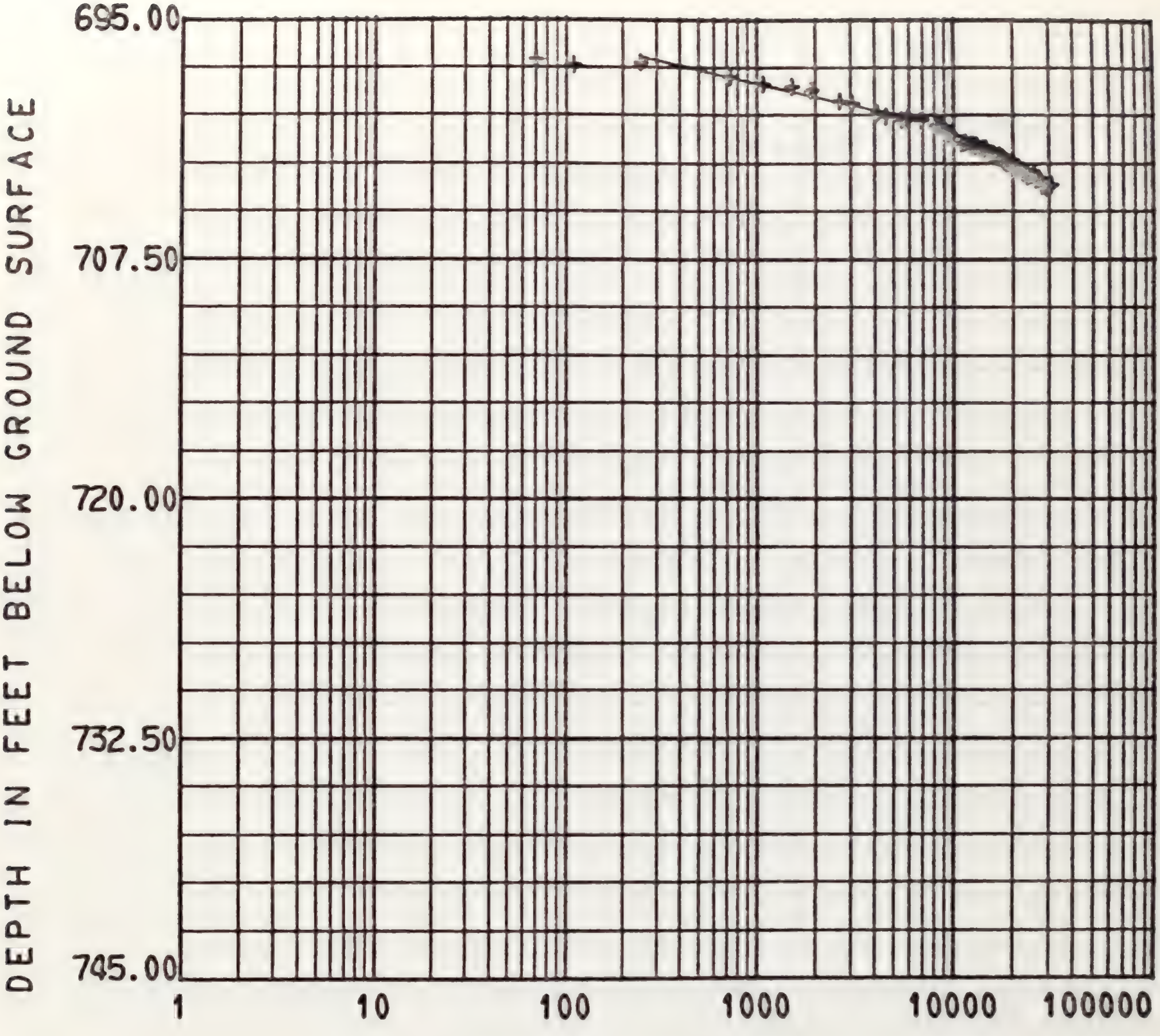
GS-11 GS-12 UPPR DRAWDOWN



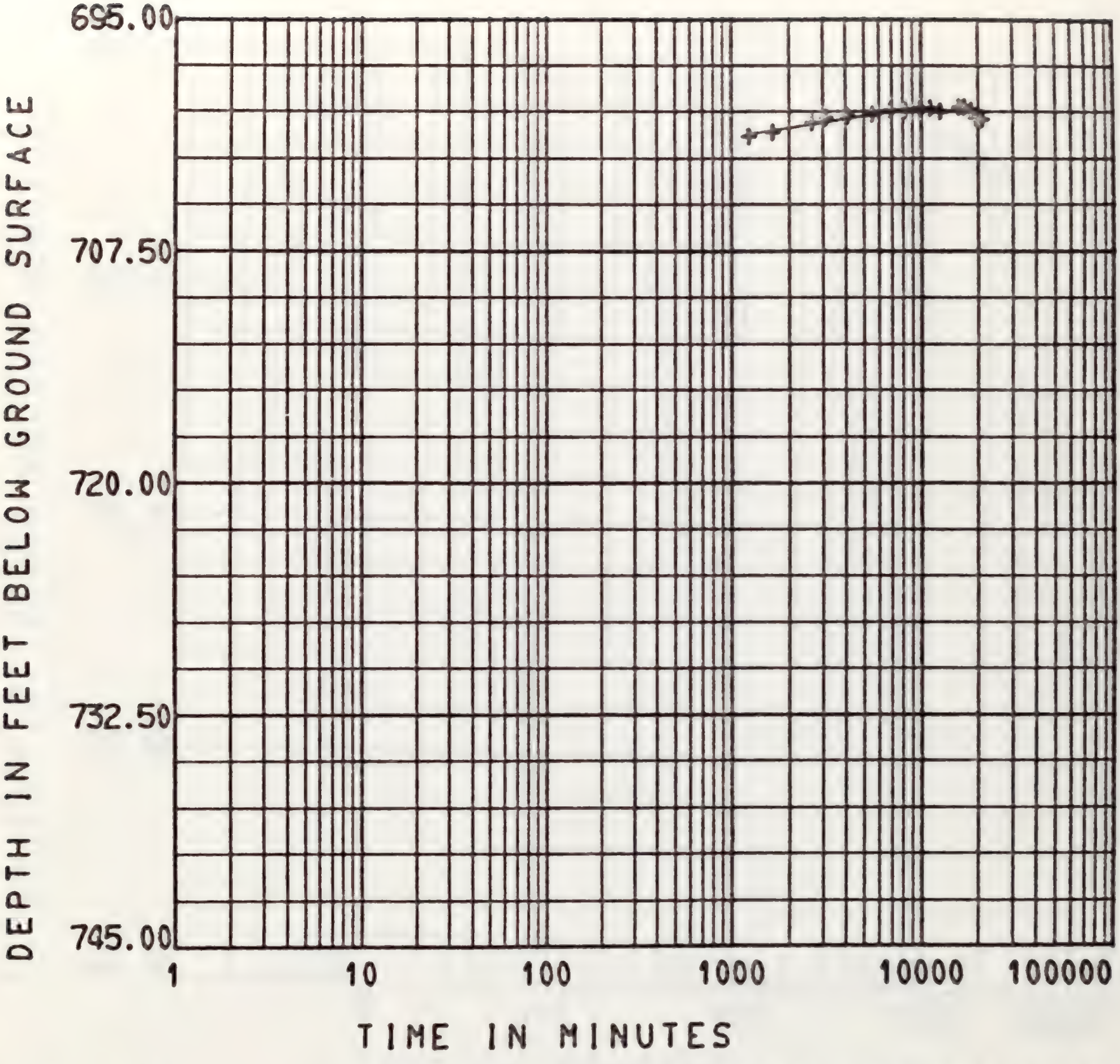
GS-11 GS-12 UPPR RECOVERY



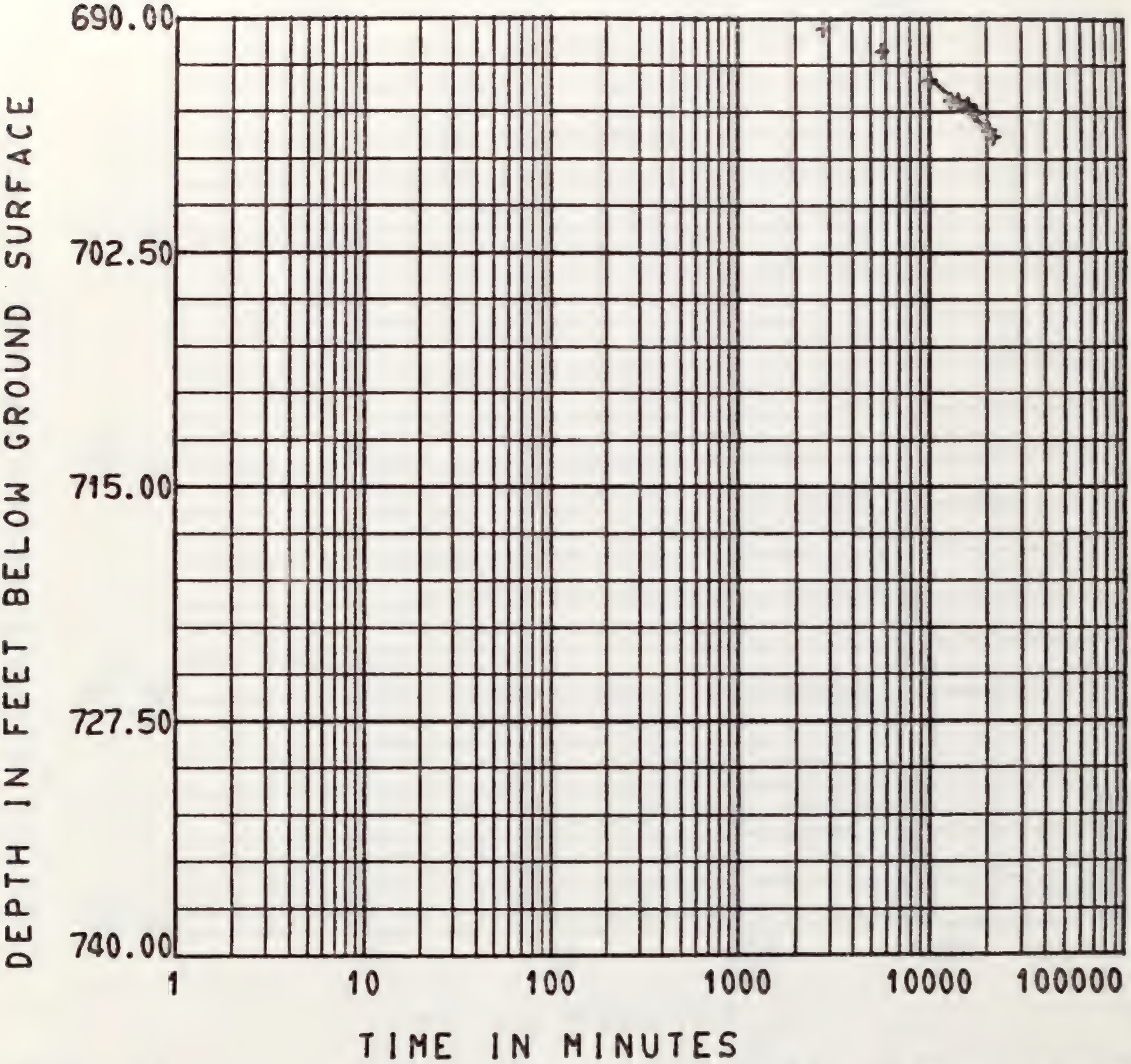
GS-11 CE 705A LOWR DRAWDOWN



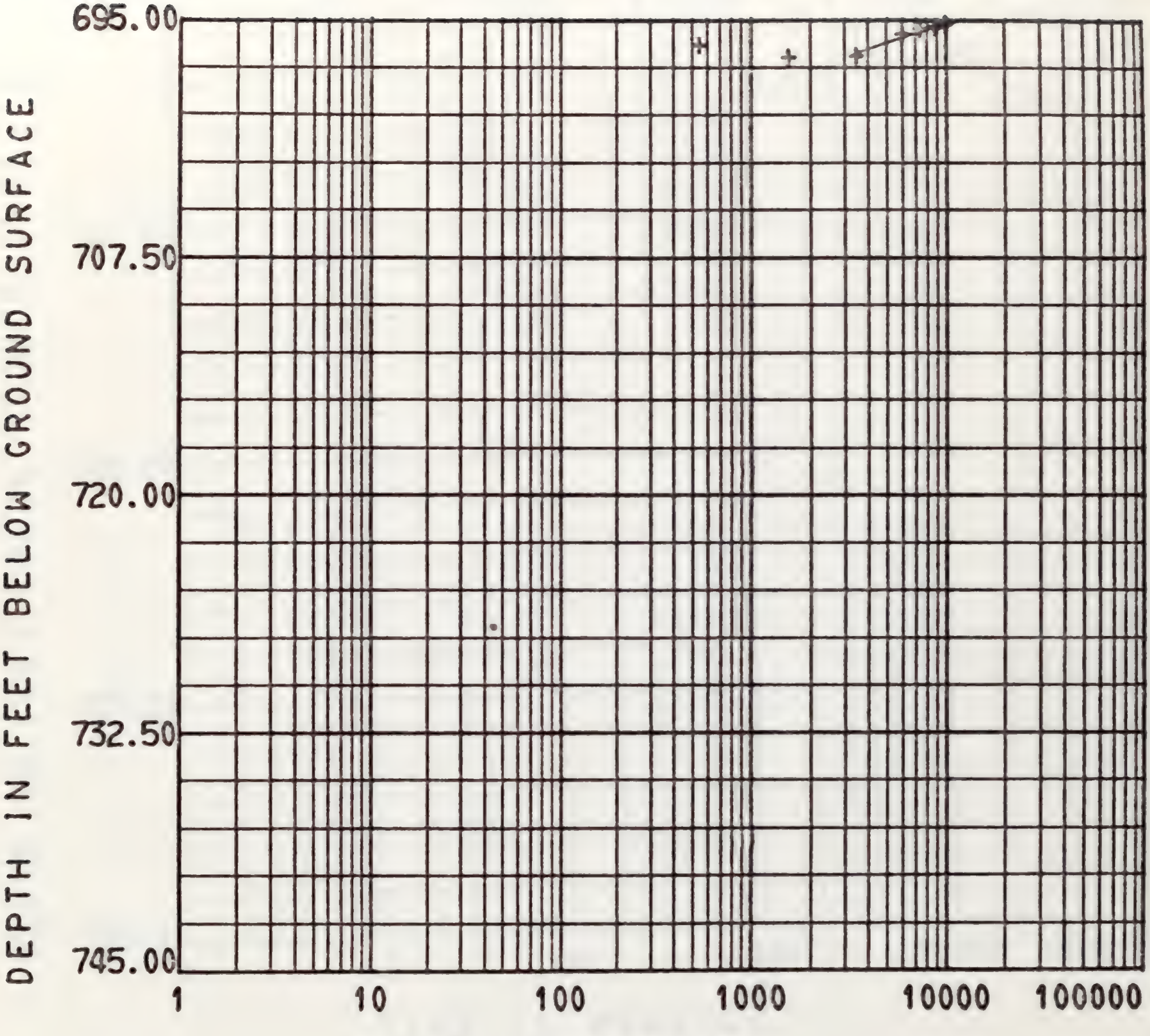
GS-11 GS-16 LOWR DRAWDOWN



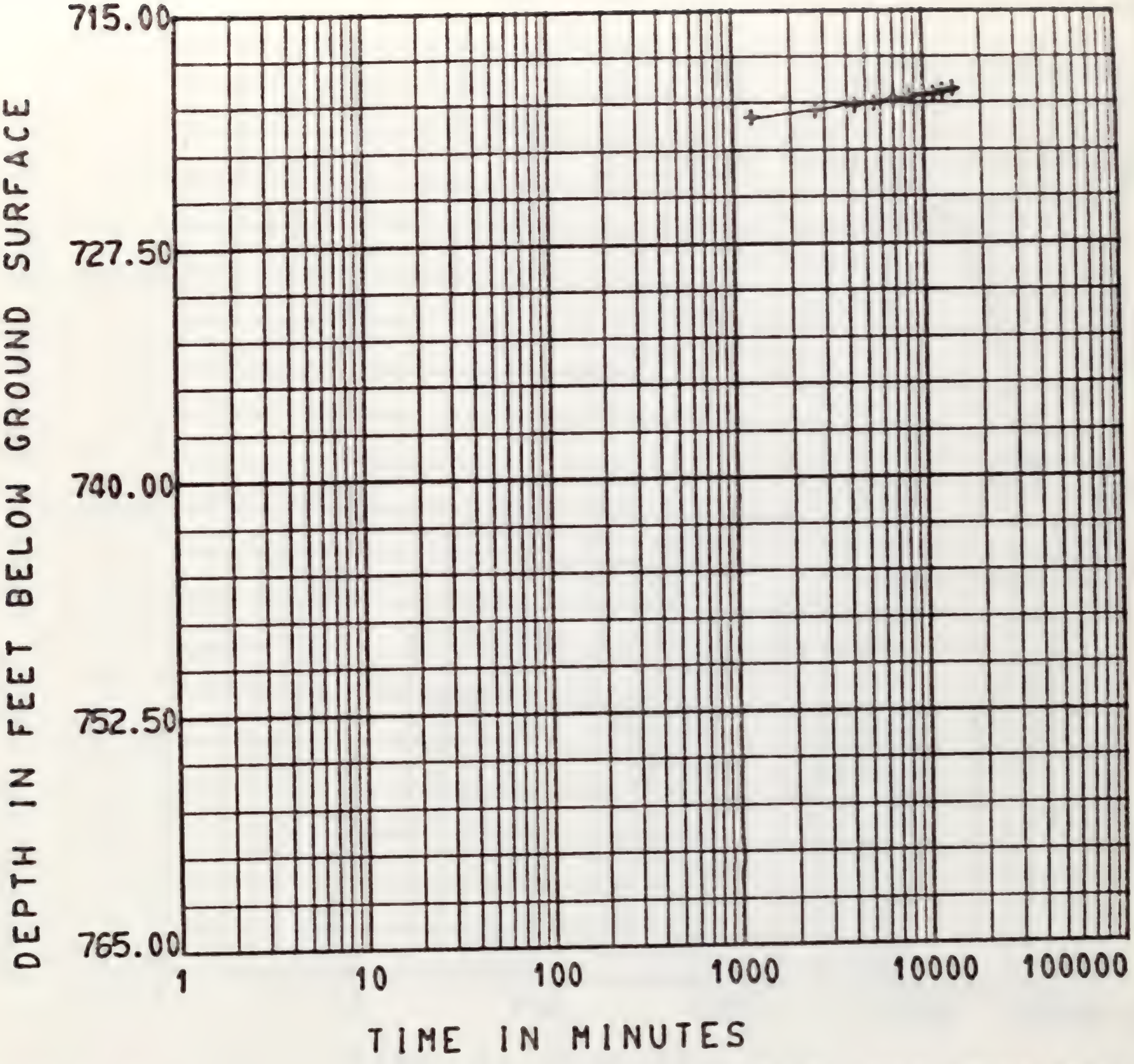
GS-11 GS-16 LOWR RECOVERY



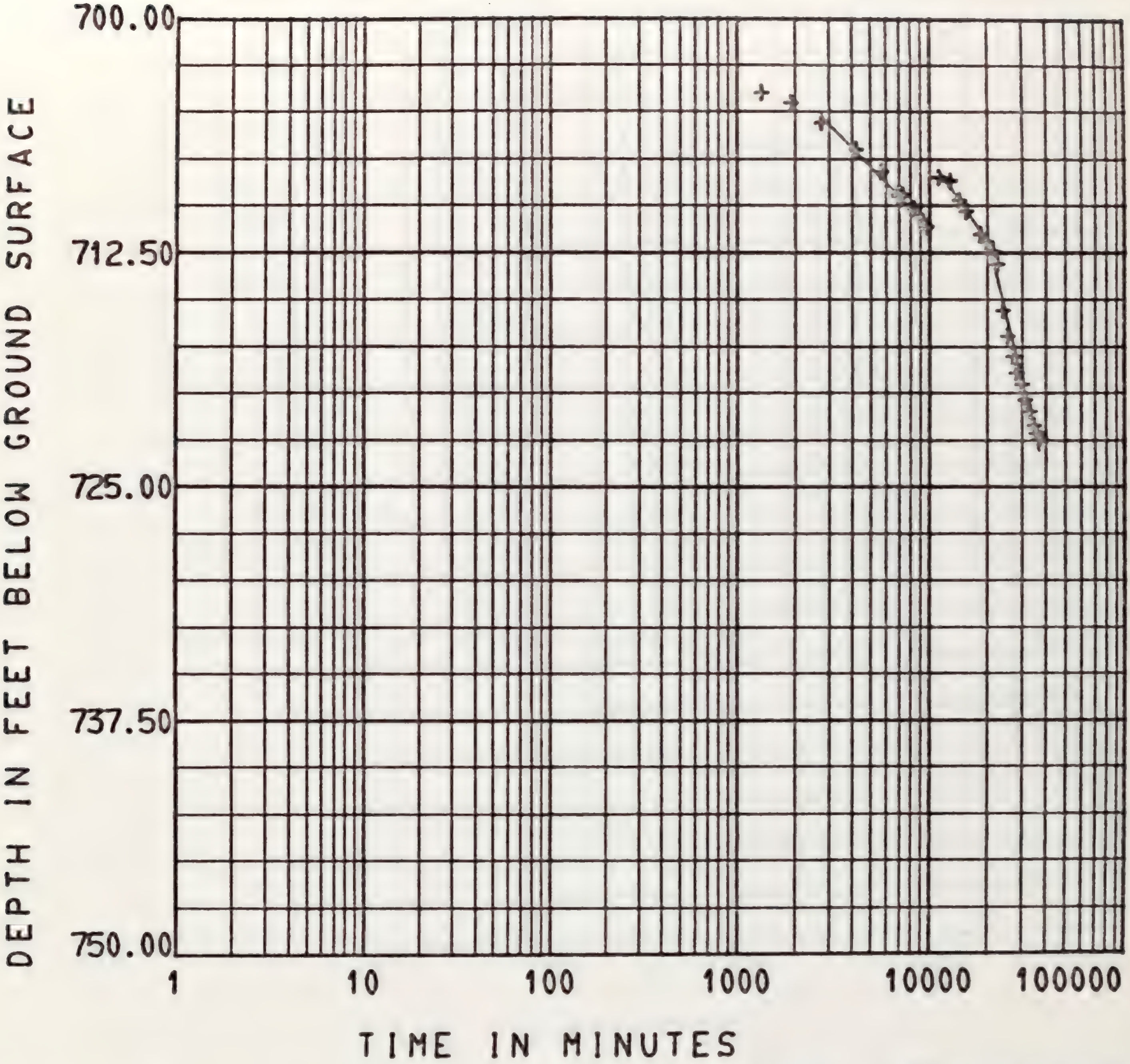
GS-11 GS-17 LOWR DRAWDOWN



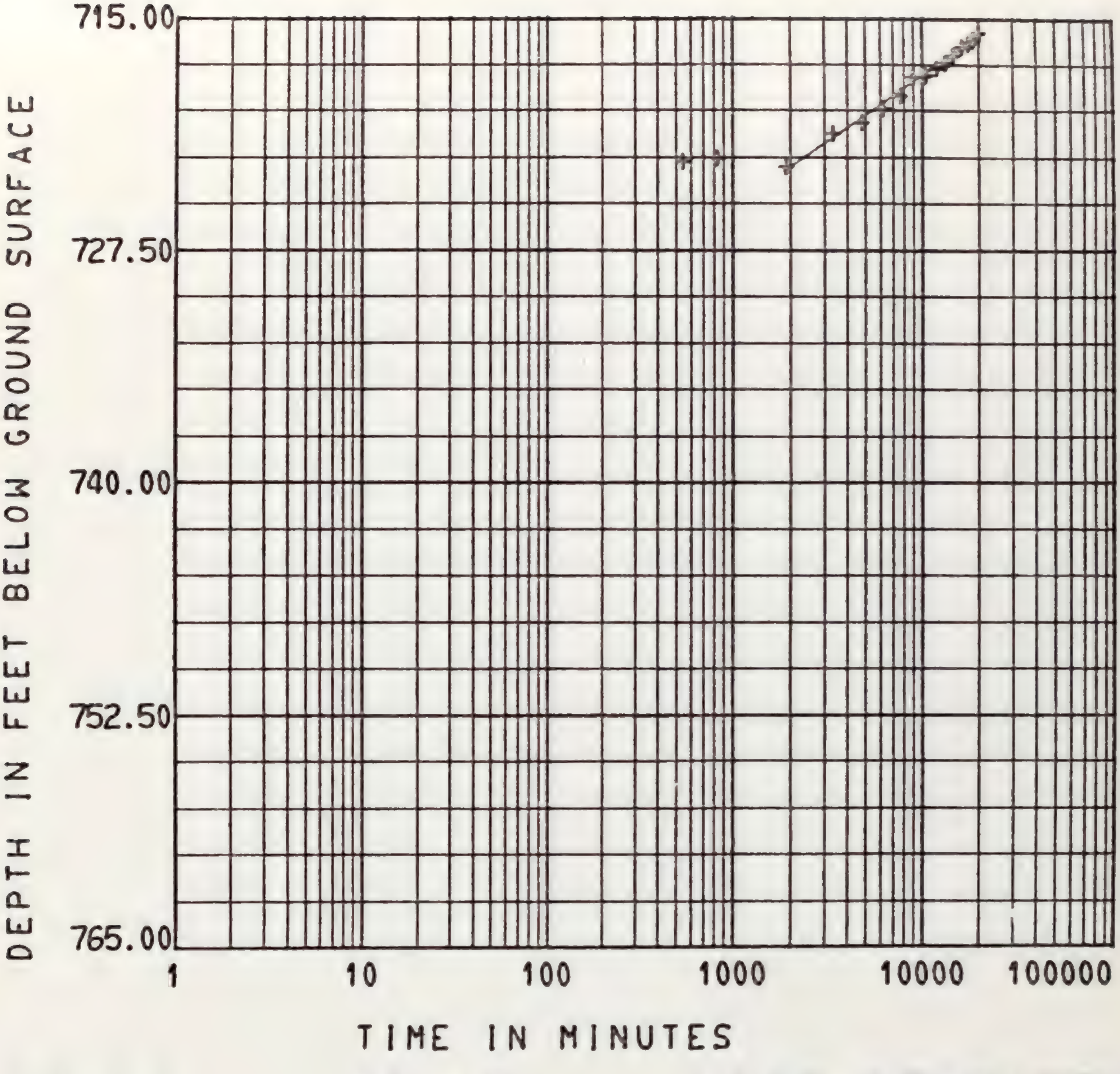
GS-11 GS-17 LOWR RECOVERY



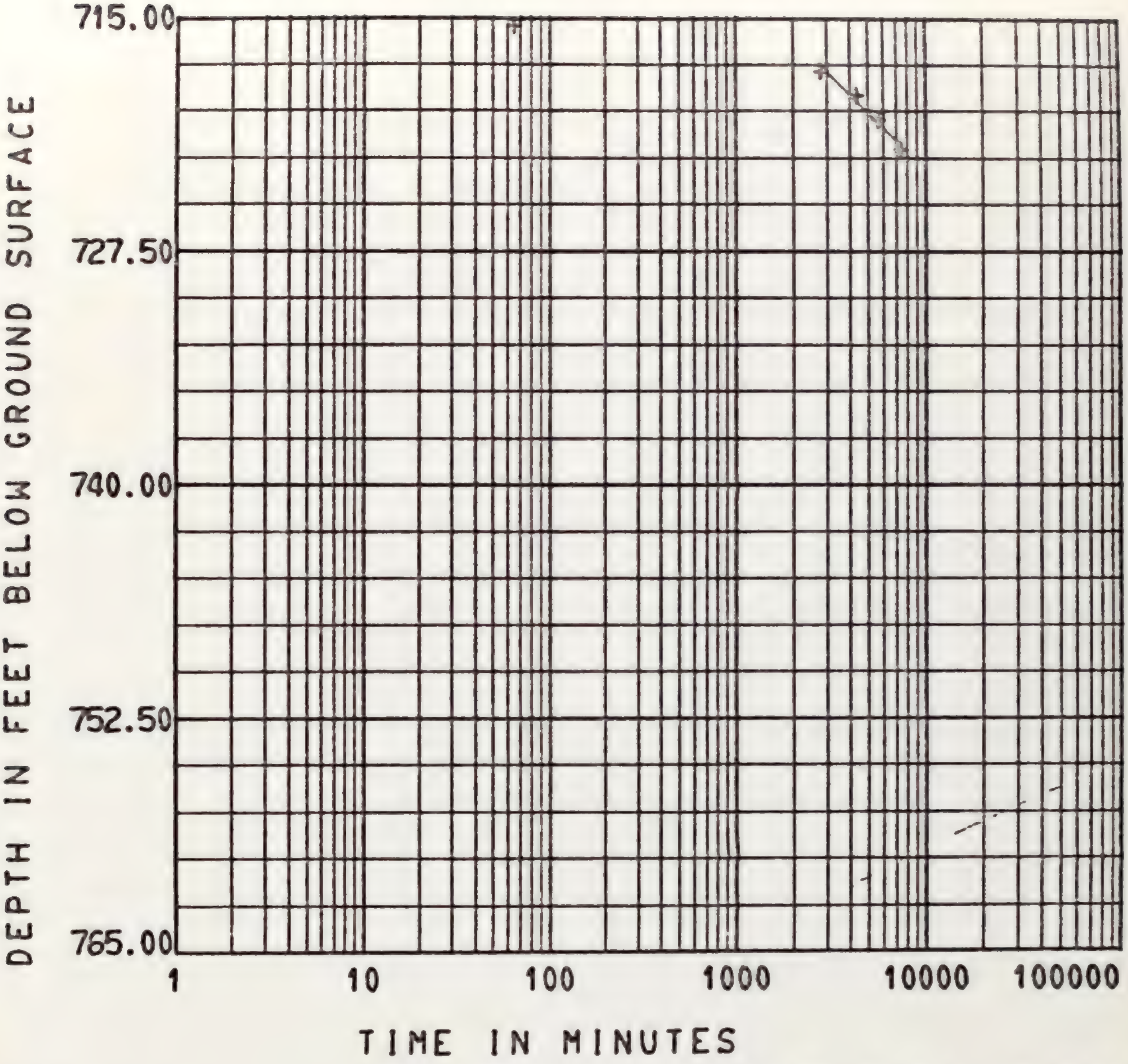
GS-11 GS-18 LOWR RECOVERY



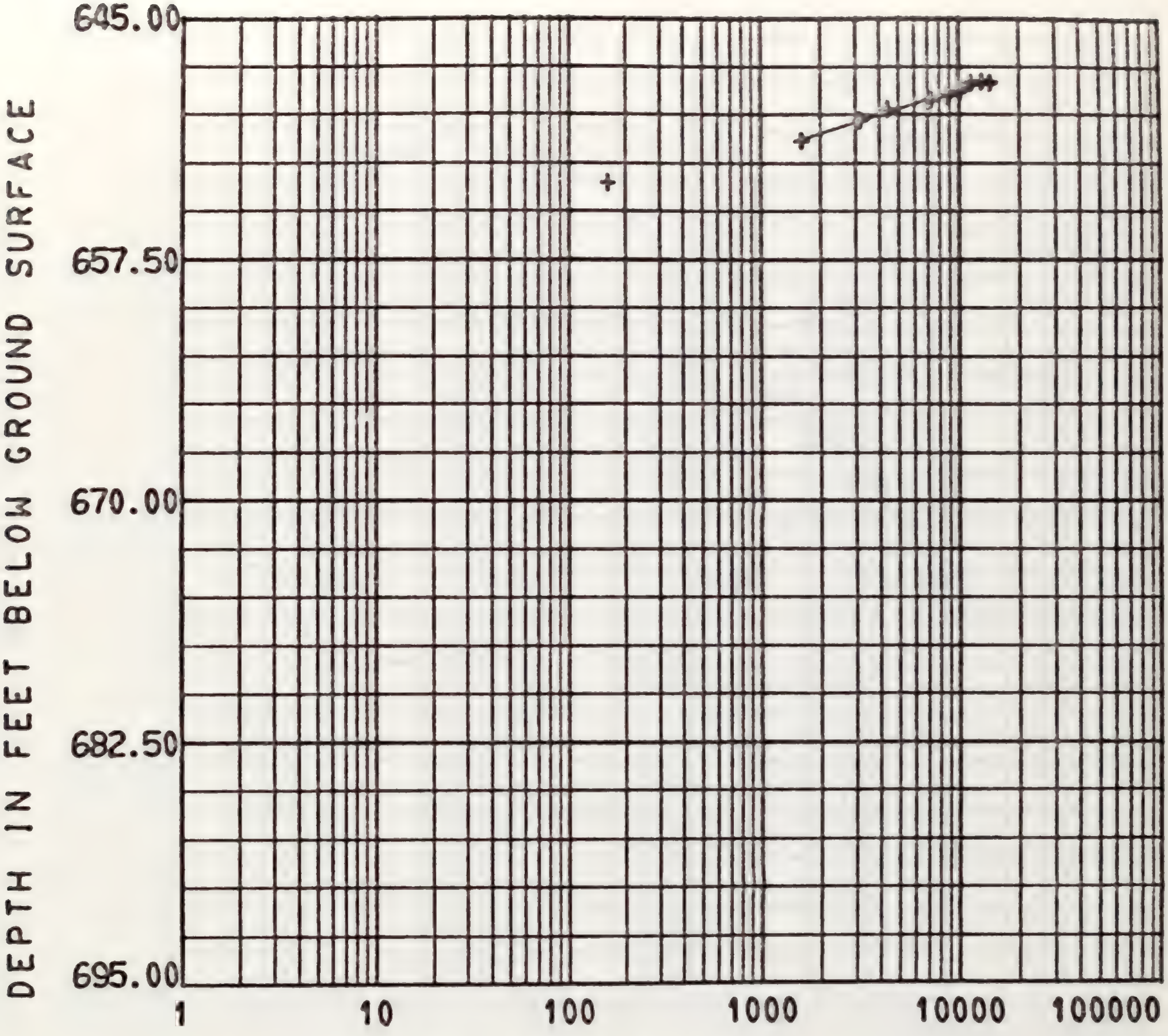
GS-11 GS-19 LOWR DRAWDOWN



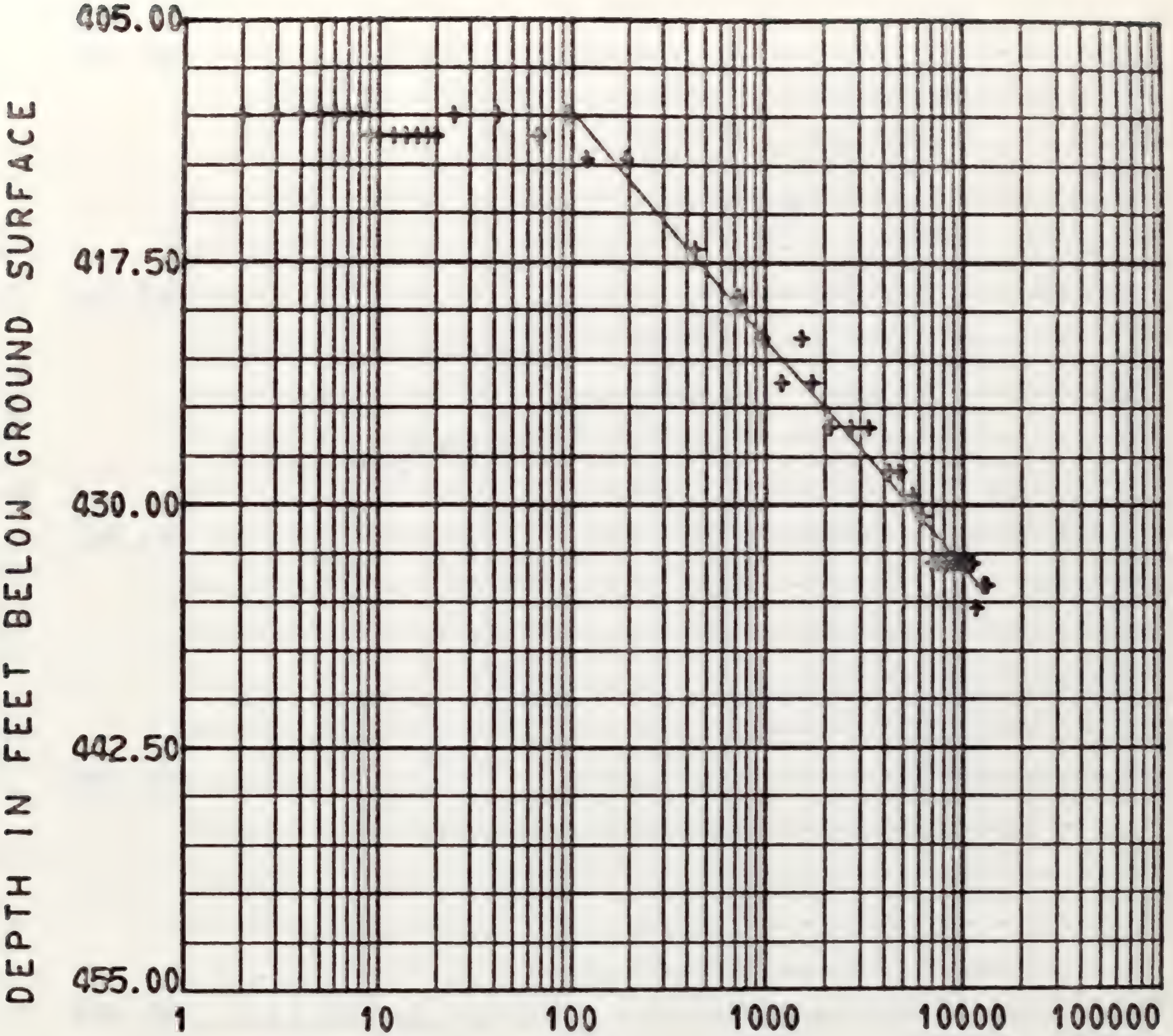
GS-11 GS-19 LOWR RECOVERY



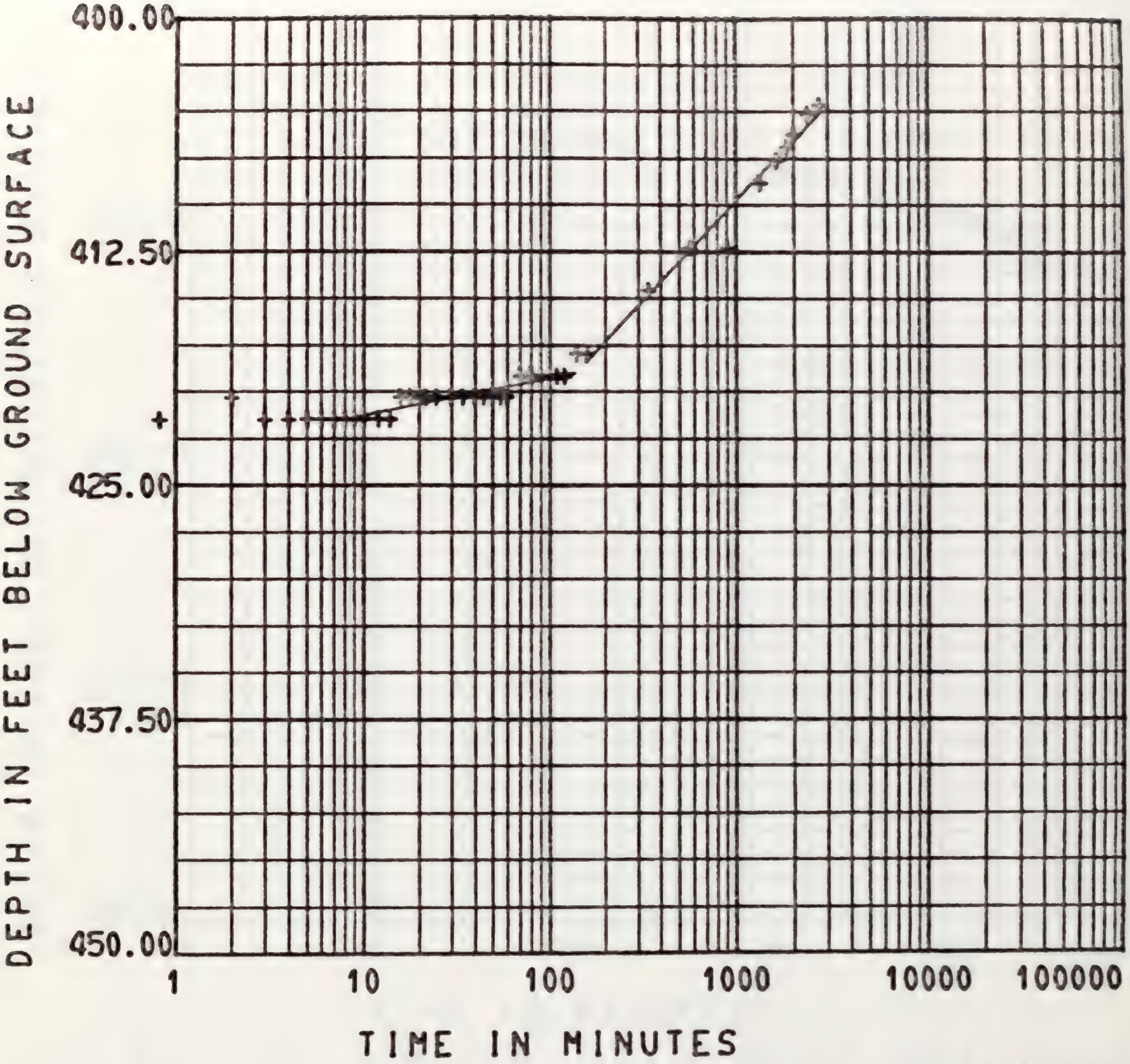
GS-11 GS-19 LOWR DRAWDOWN



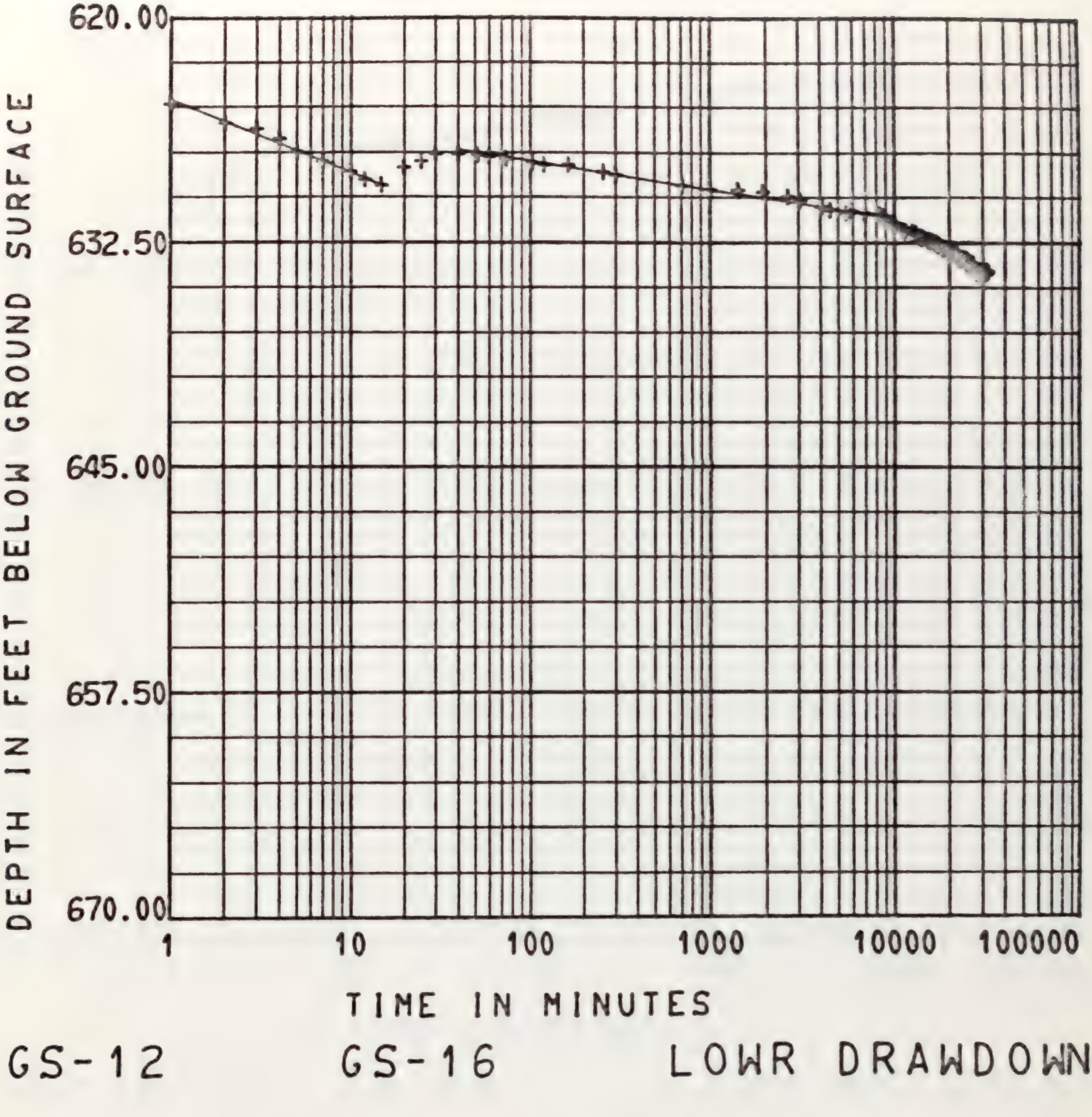
GS-12 GS-19 LOWR RECOVERY



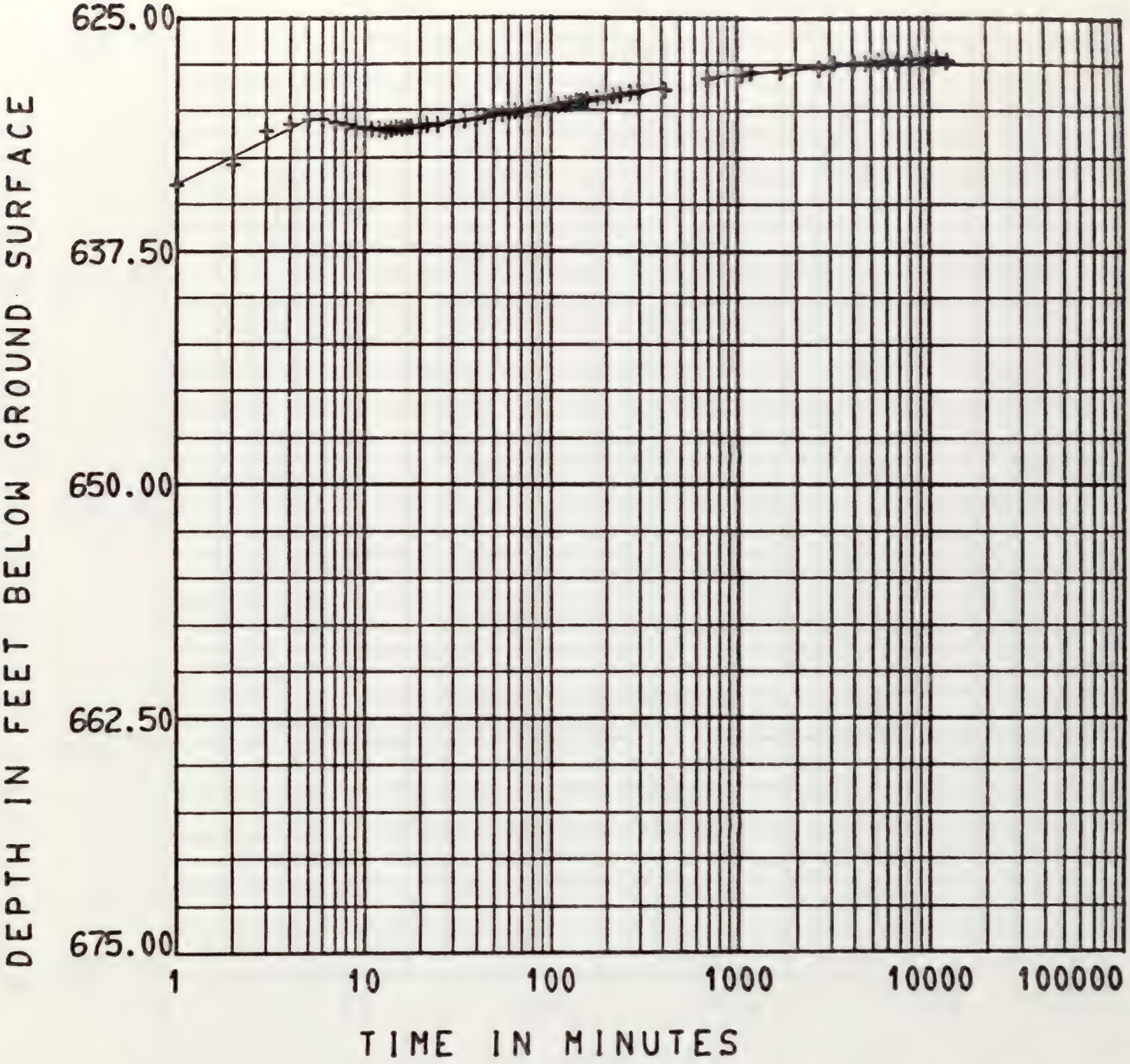
GS-12 GS-12 UPPR DRAWDOWN



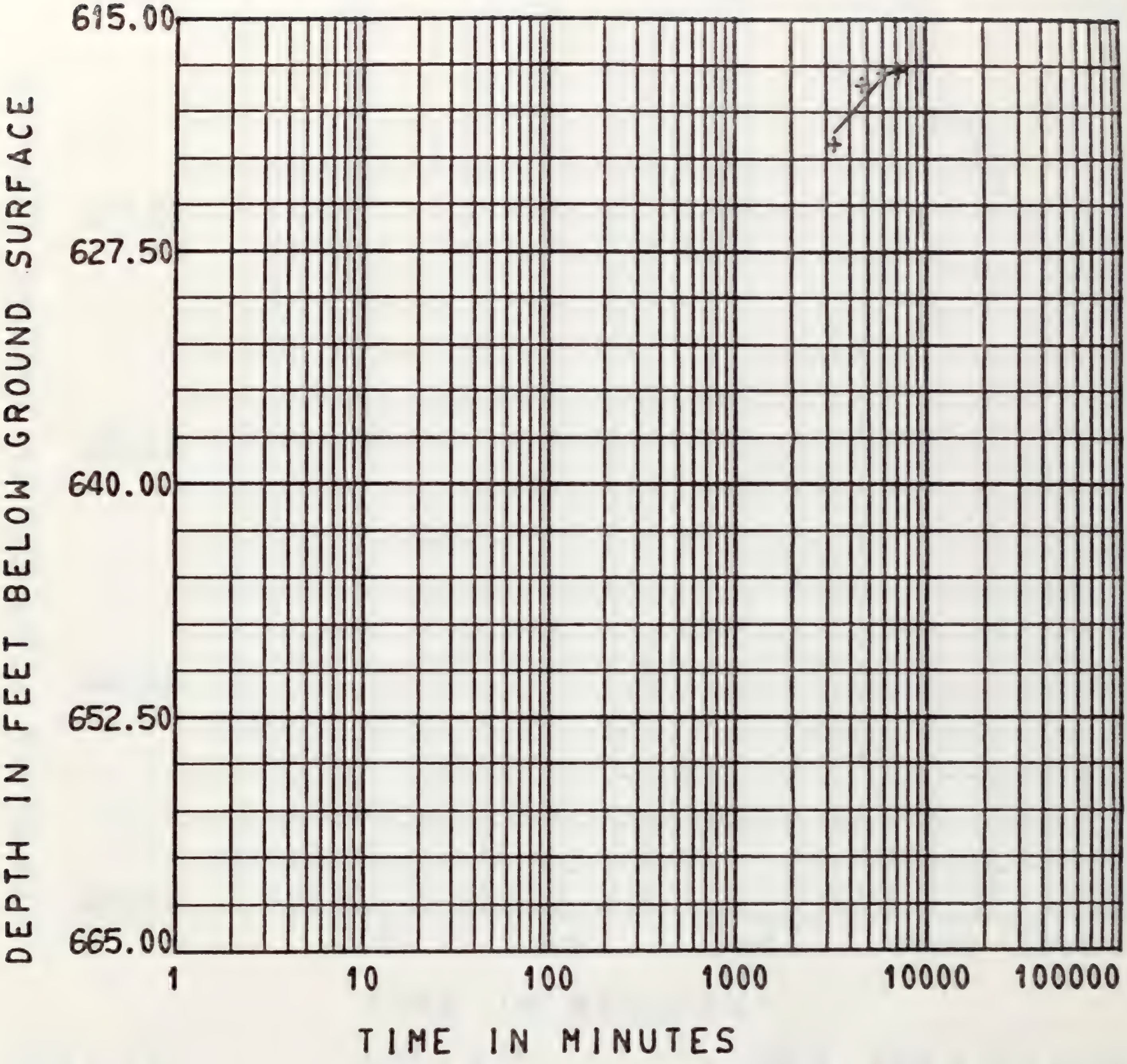
GS-12 GS-12 UPPR RECOVERY



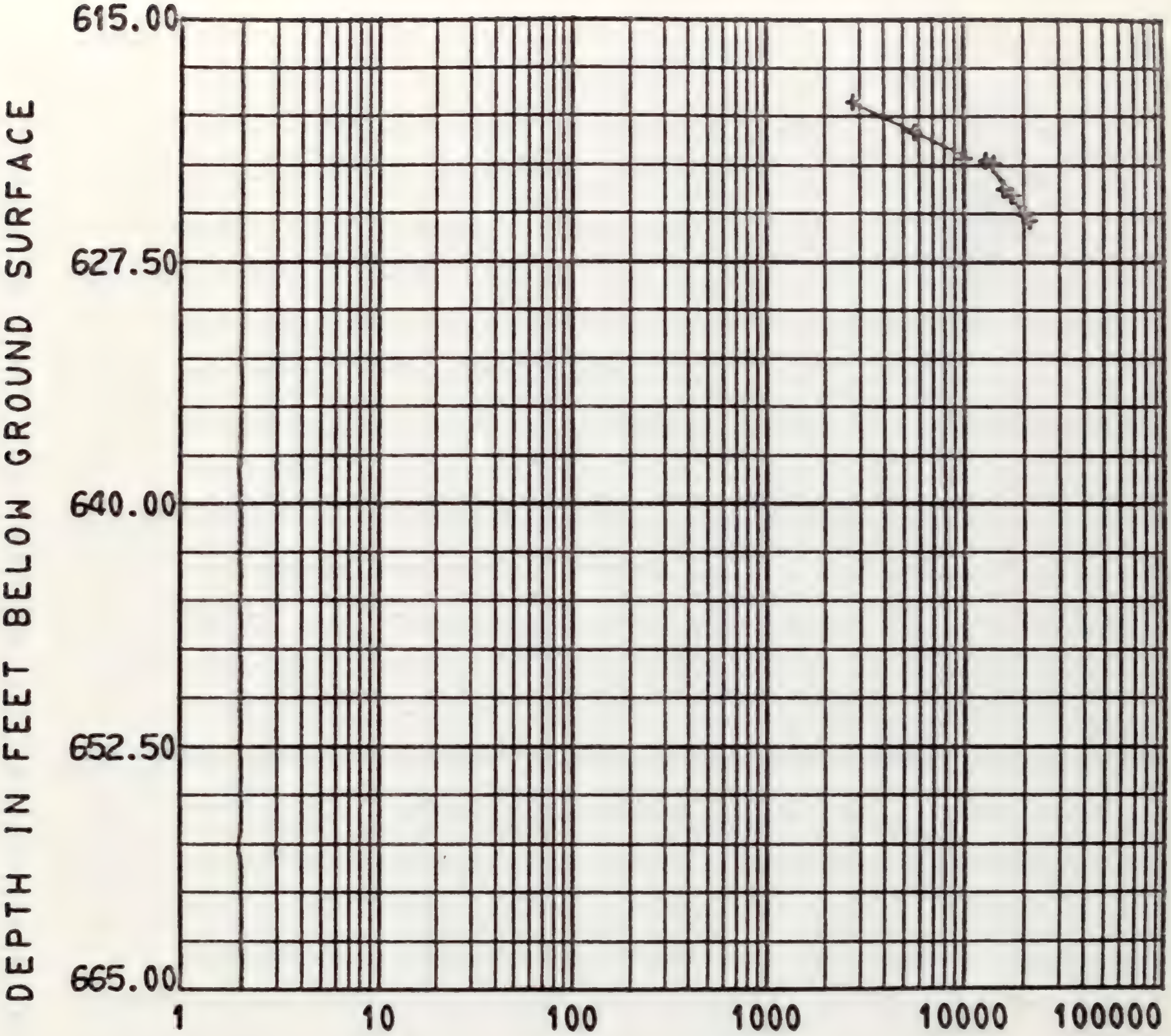
GS-12 GS-16 LOWR DRAWDOWN



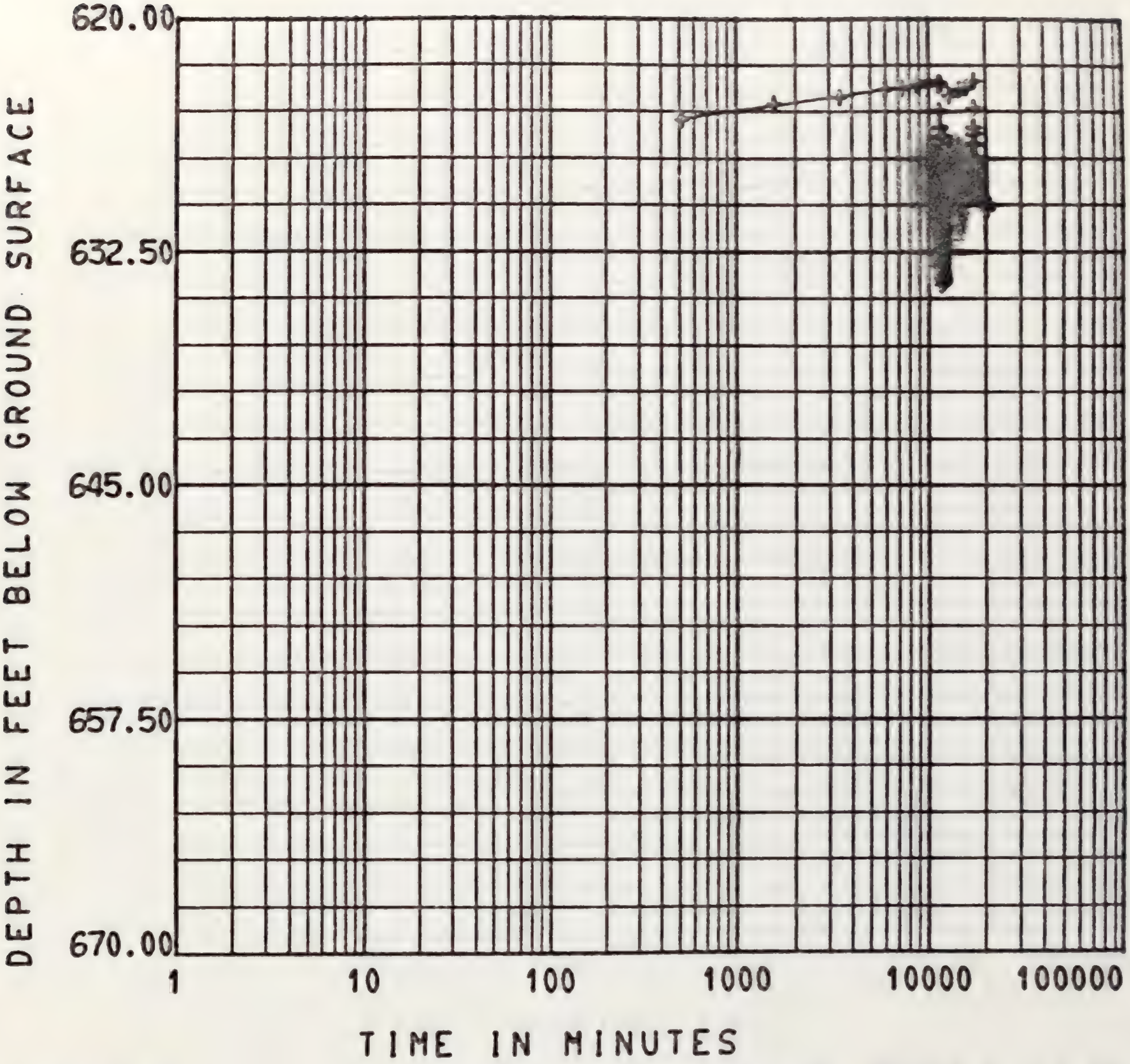
GS-12 GS-16 LOWR RECOVERY



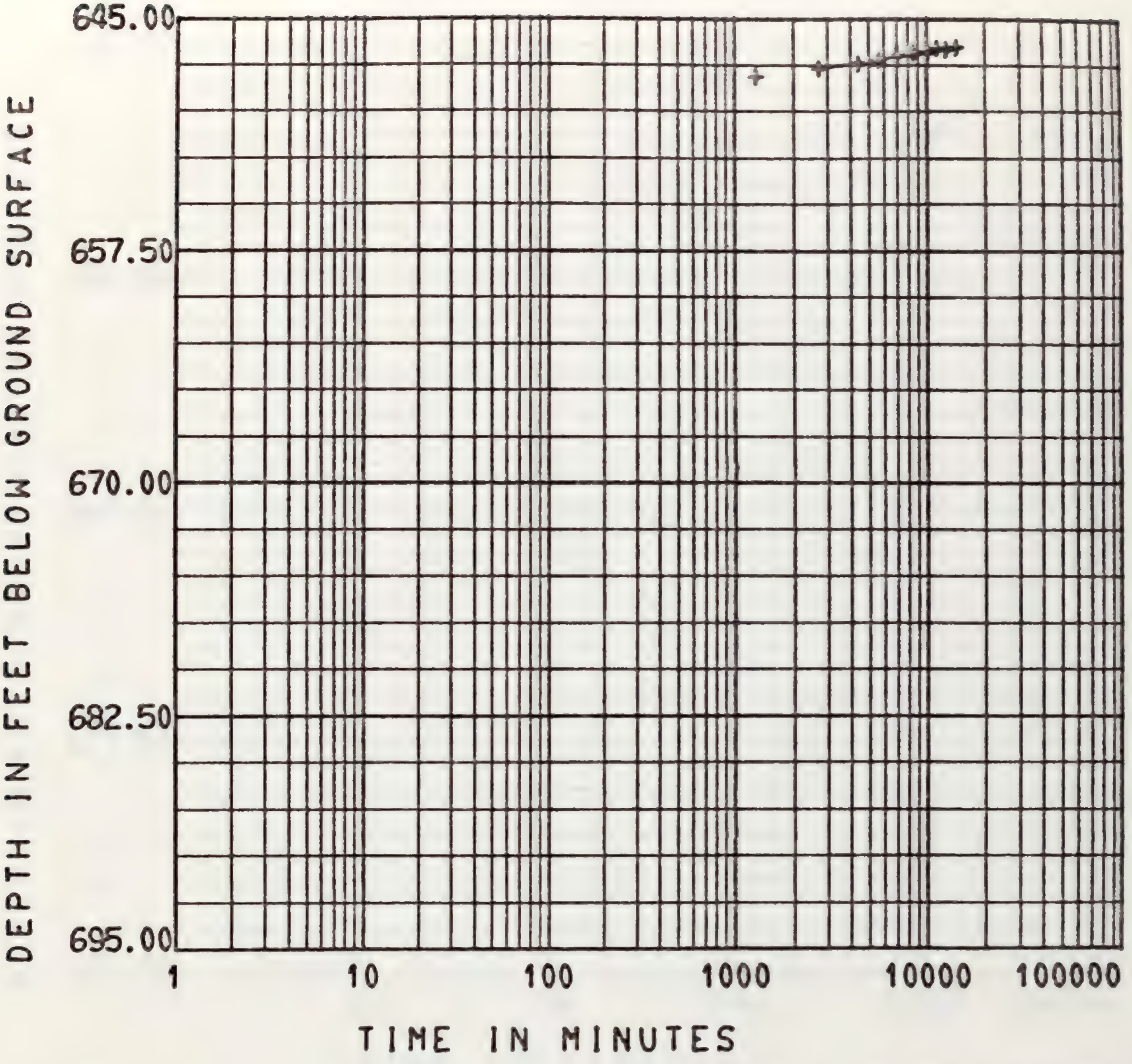
GS-12 GS-17 LOWR RECOVERY



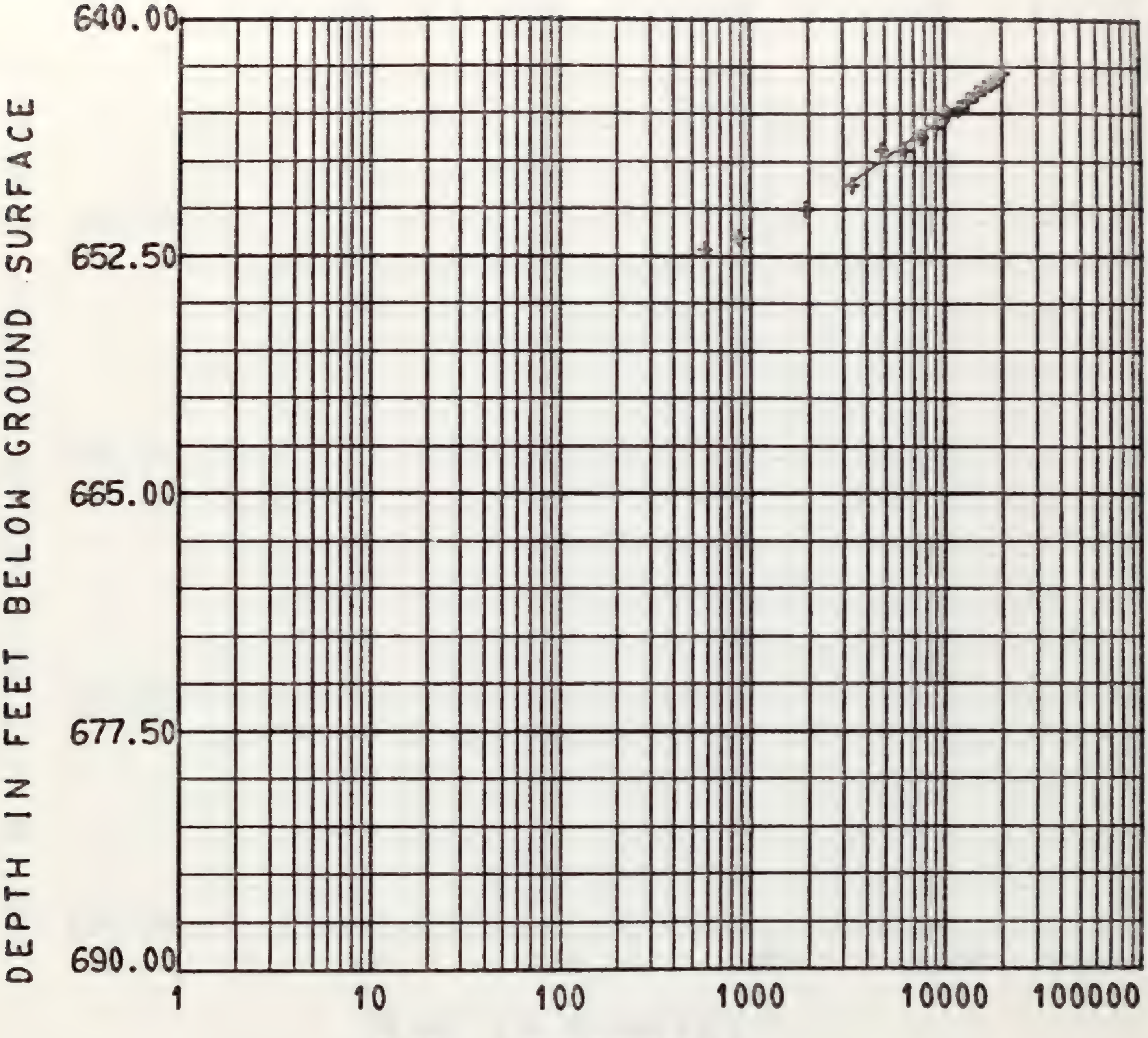
GS-12 GS-17 LOWR DRAWDOWN



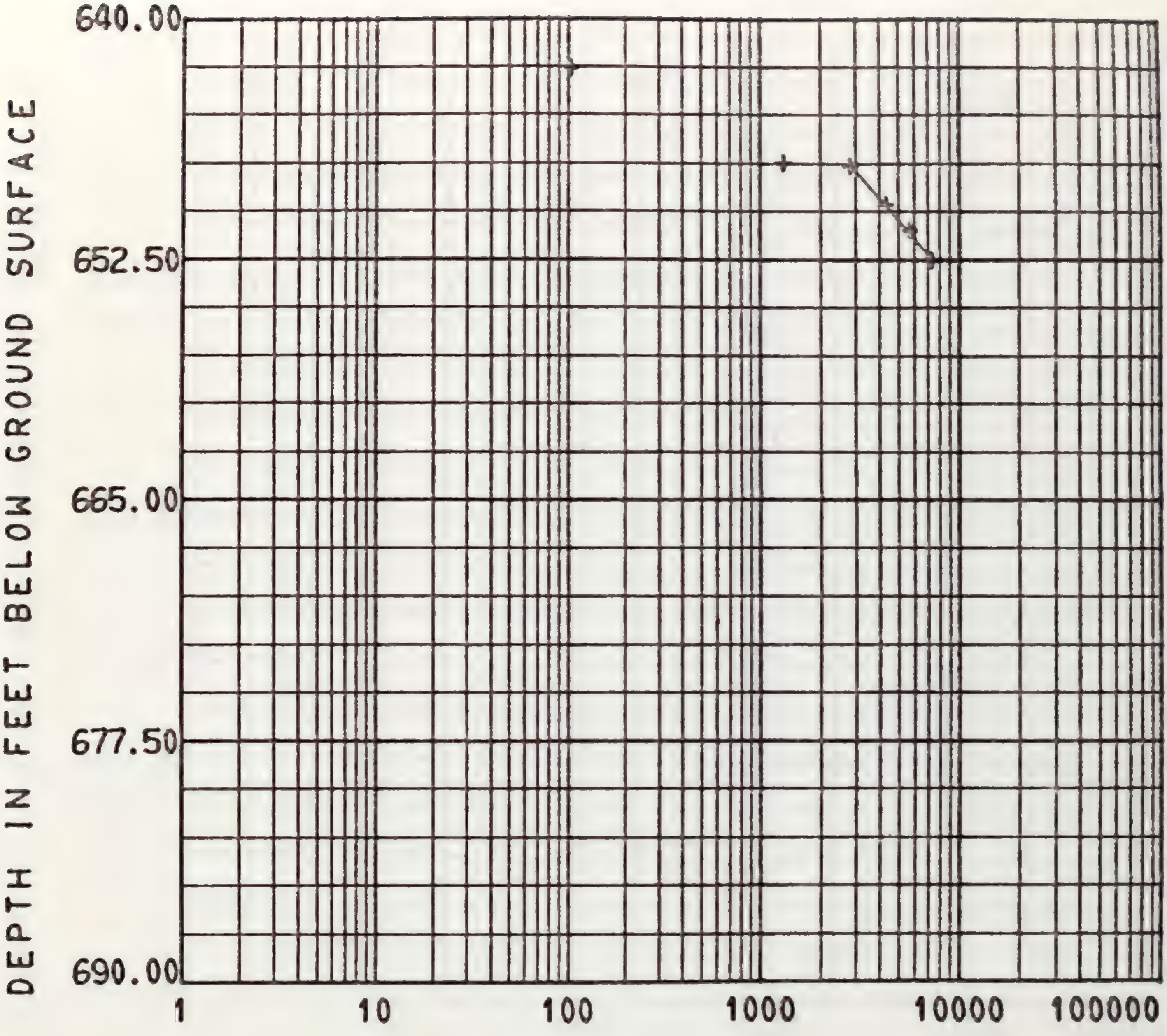
GS-12 GS-17 LOWR RECOVERY



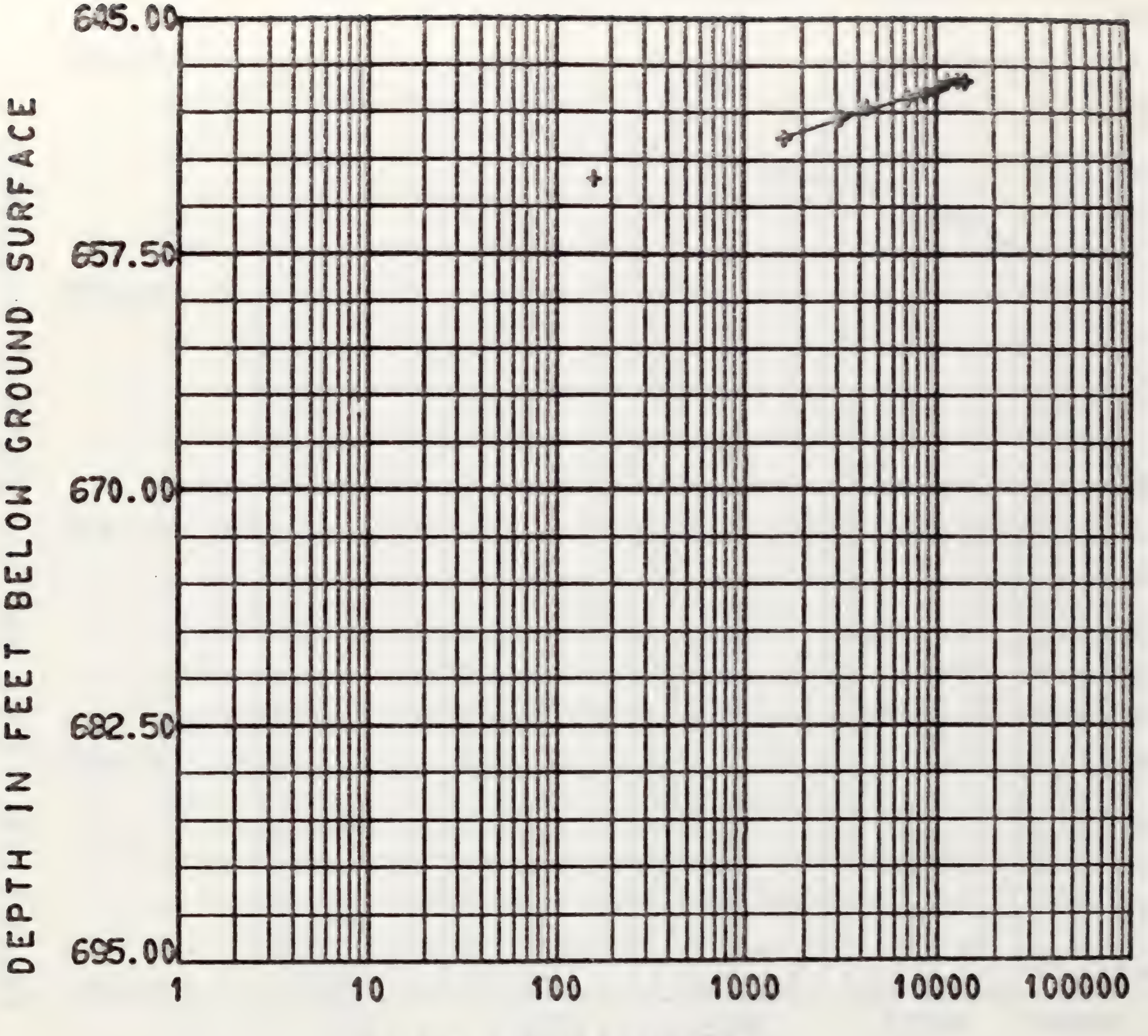
GS-12 GS-18 LOWR RECOVERY



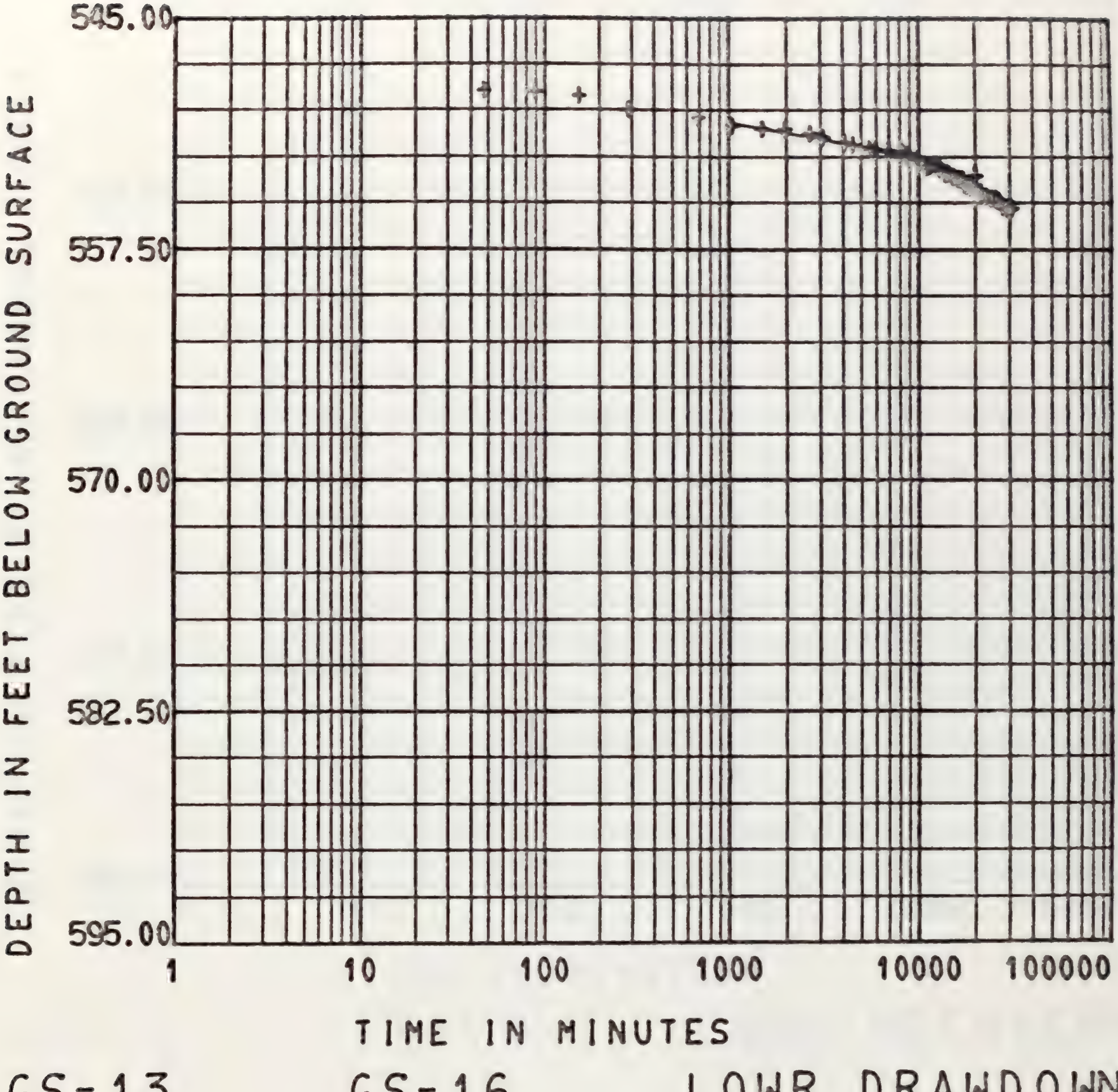
GS-12 GS-19 LOWR RECOVERY



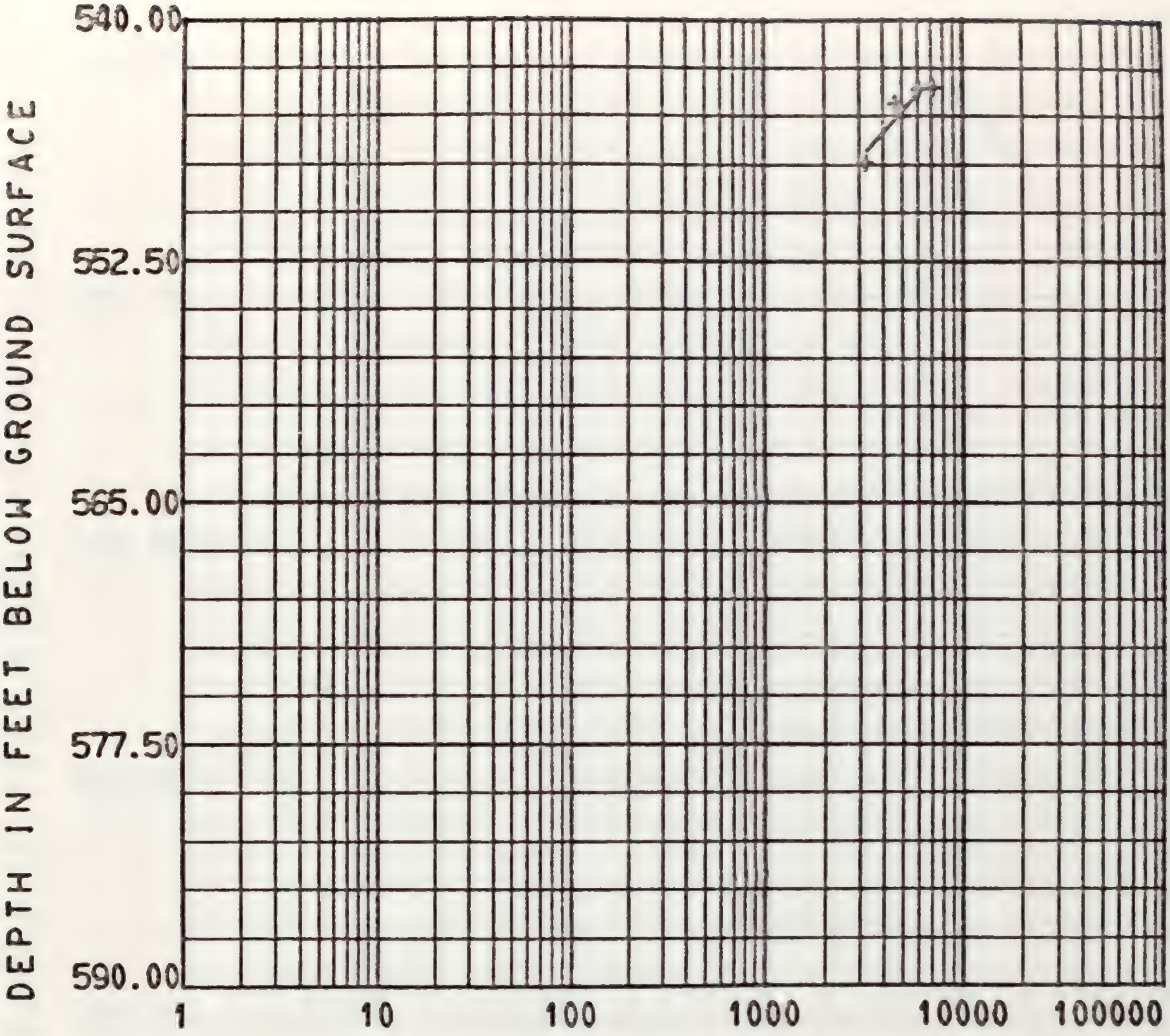
GS-12 GS-19 LOWR DRAWDOWN



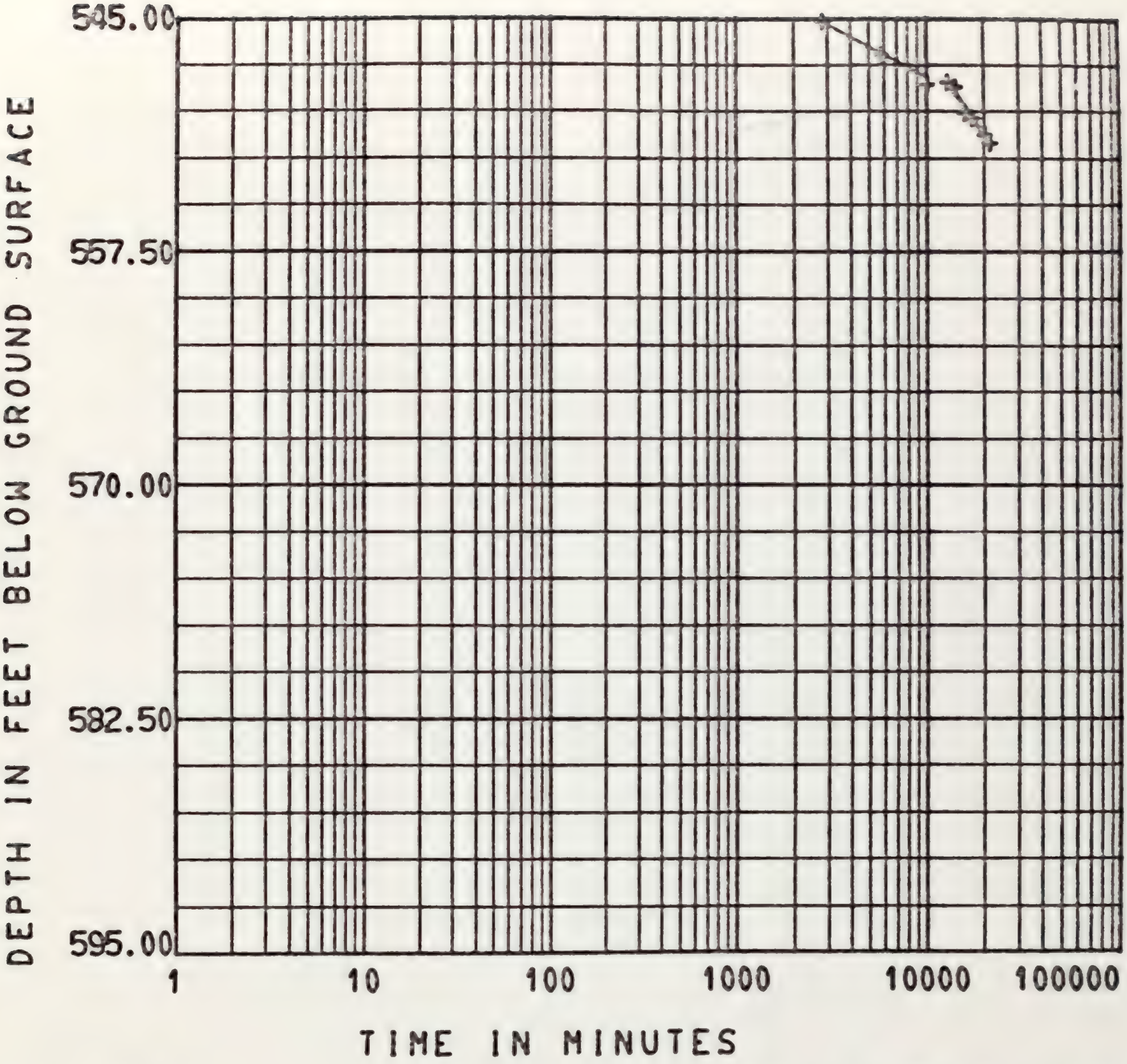
GS-12 GS-19 LOWR RECOVERY



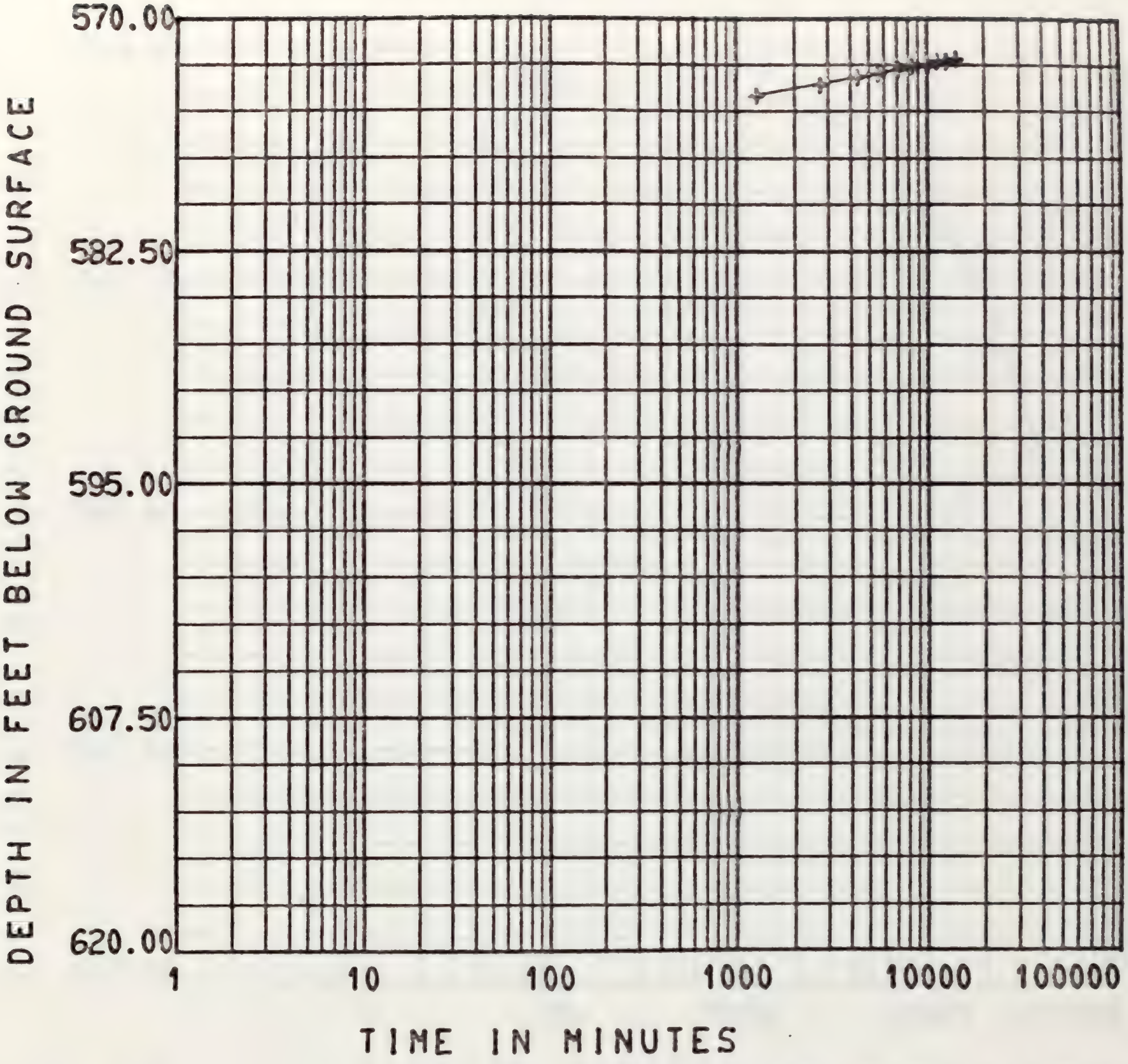
GS-13 GS-16 LOWR DRAWDOWN



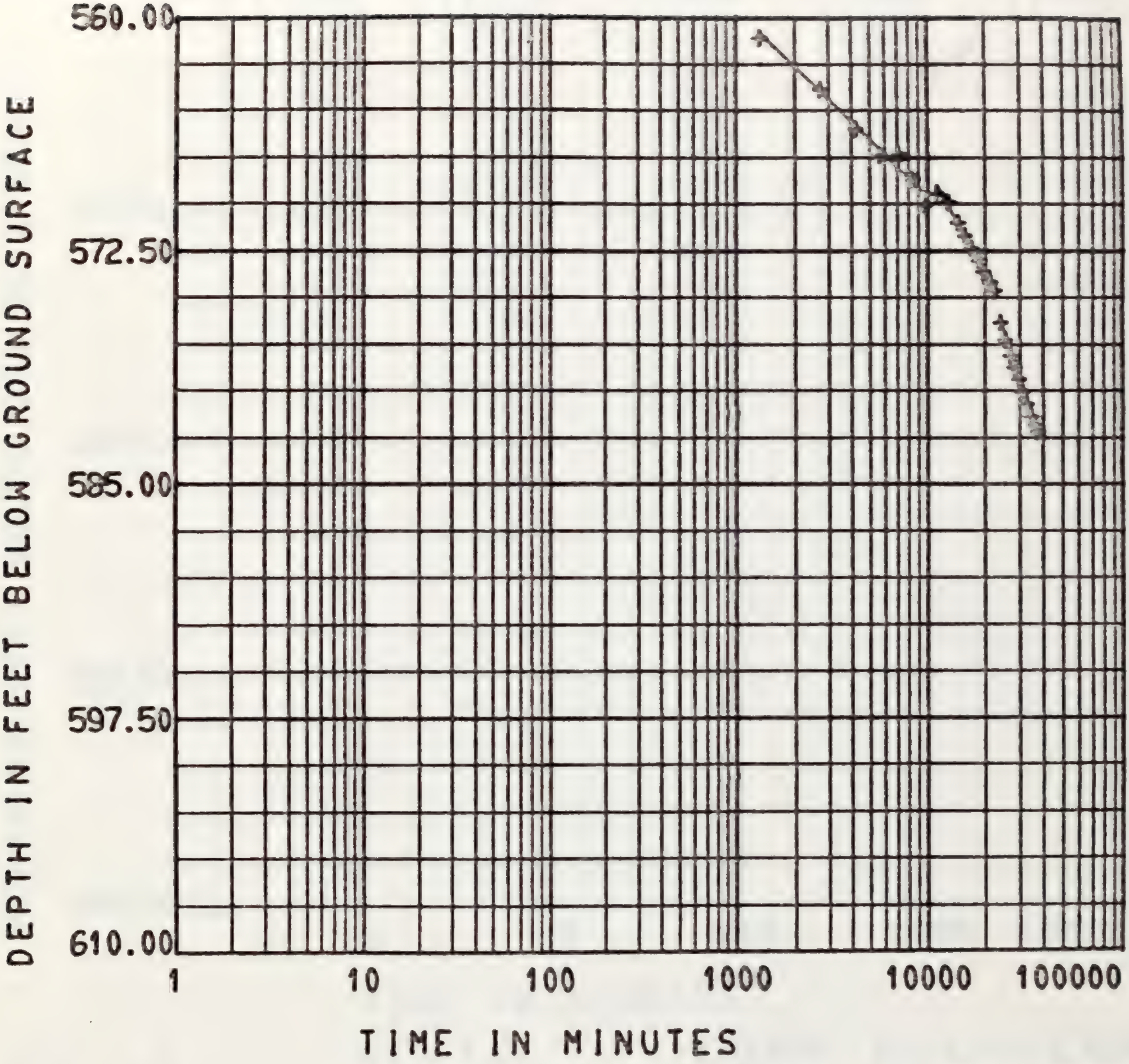
GS-13 GS-17 LOWR RECOVERY



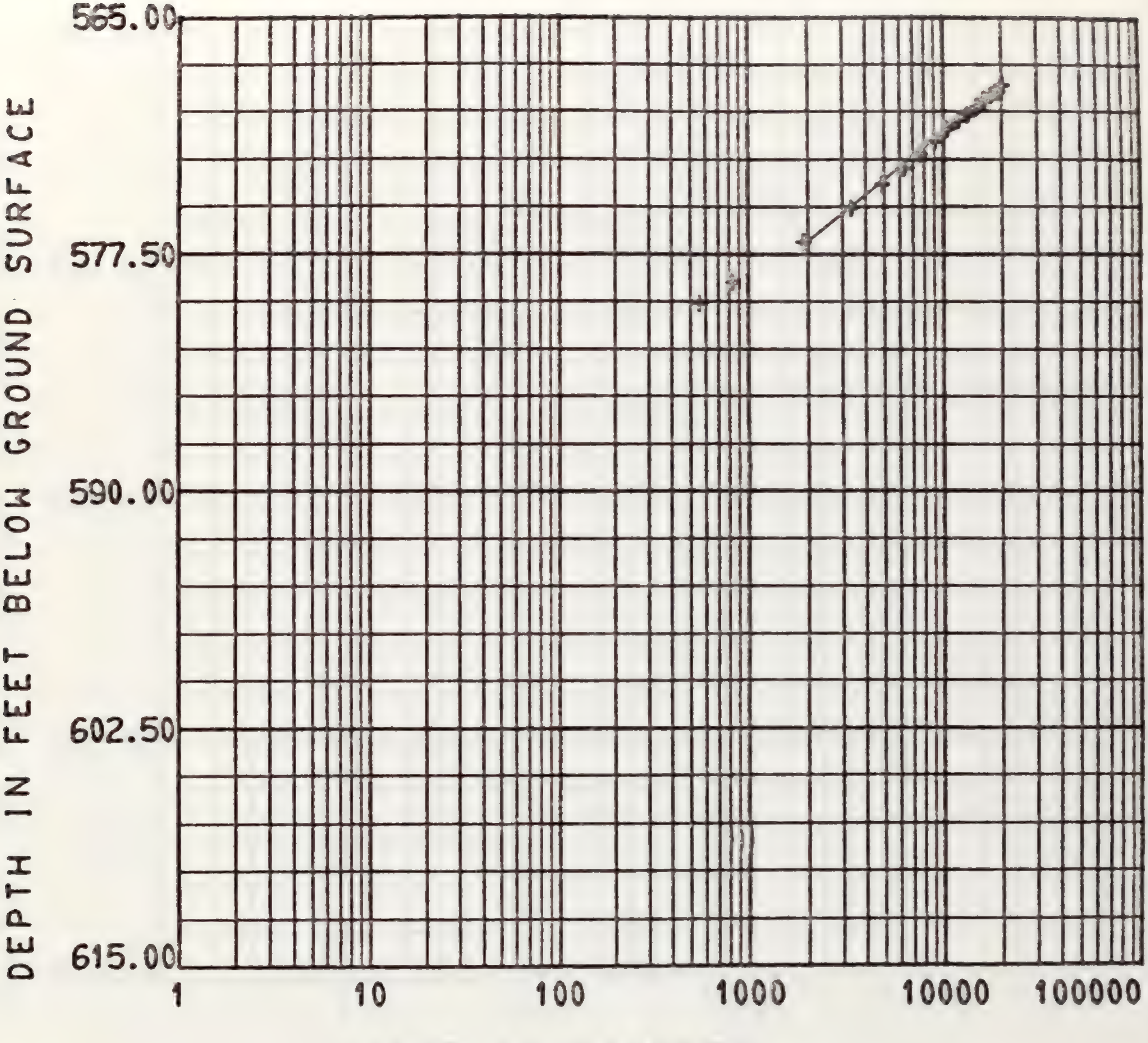
GS-13 GS-17 LOWR DRAWDOWN



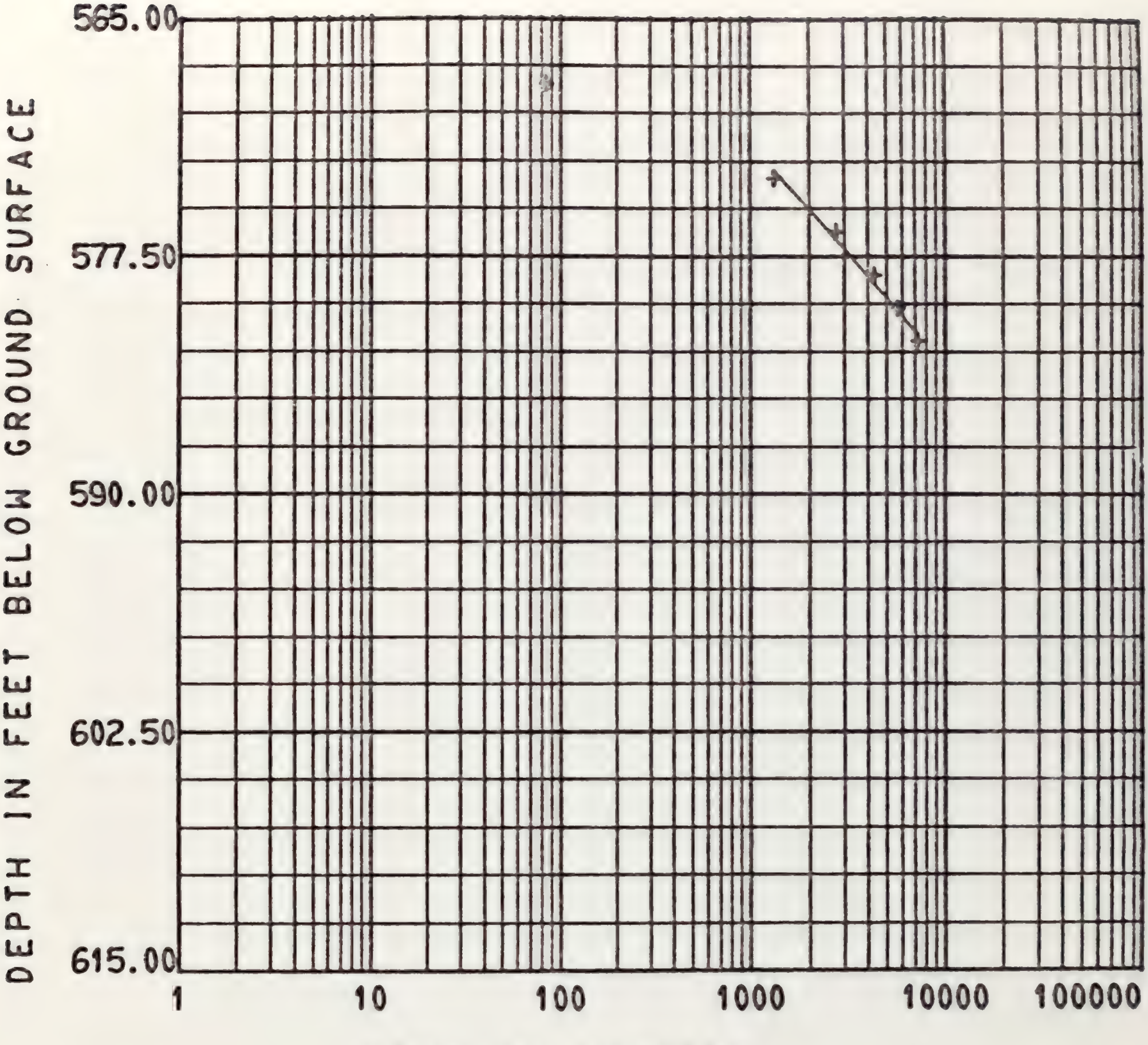
GS-13 GS-18 LOWR RECOVERY



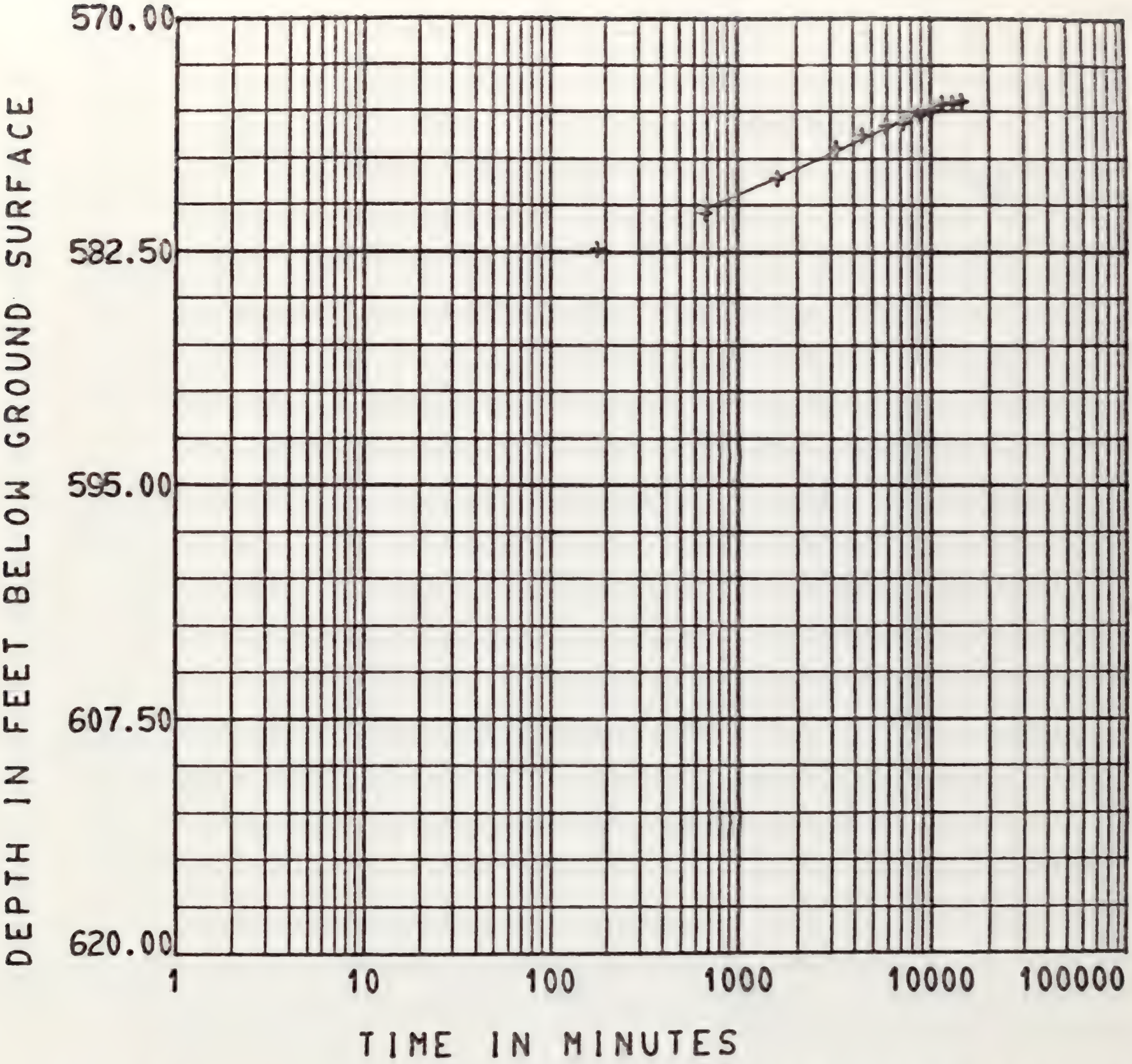
GS-13 GS-19 LOWR DRAWDOWN



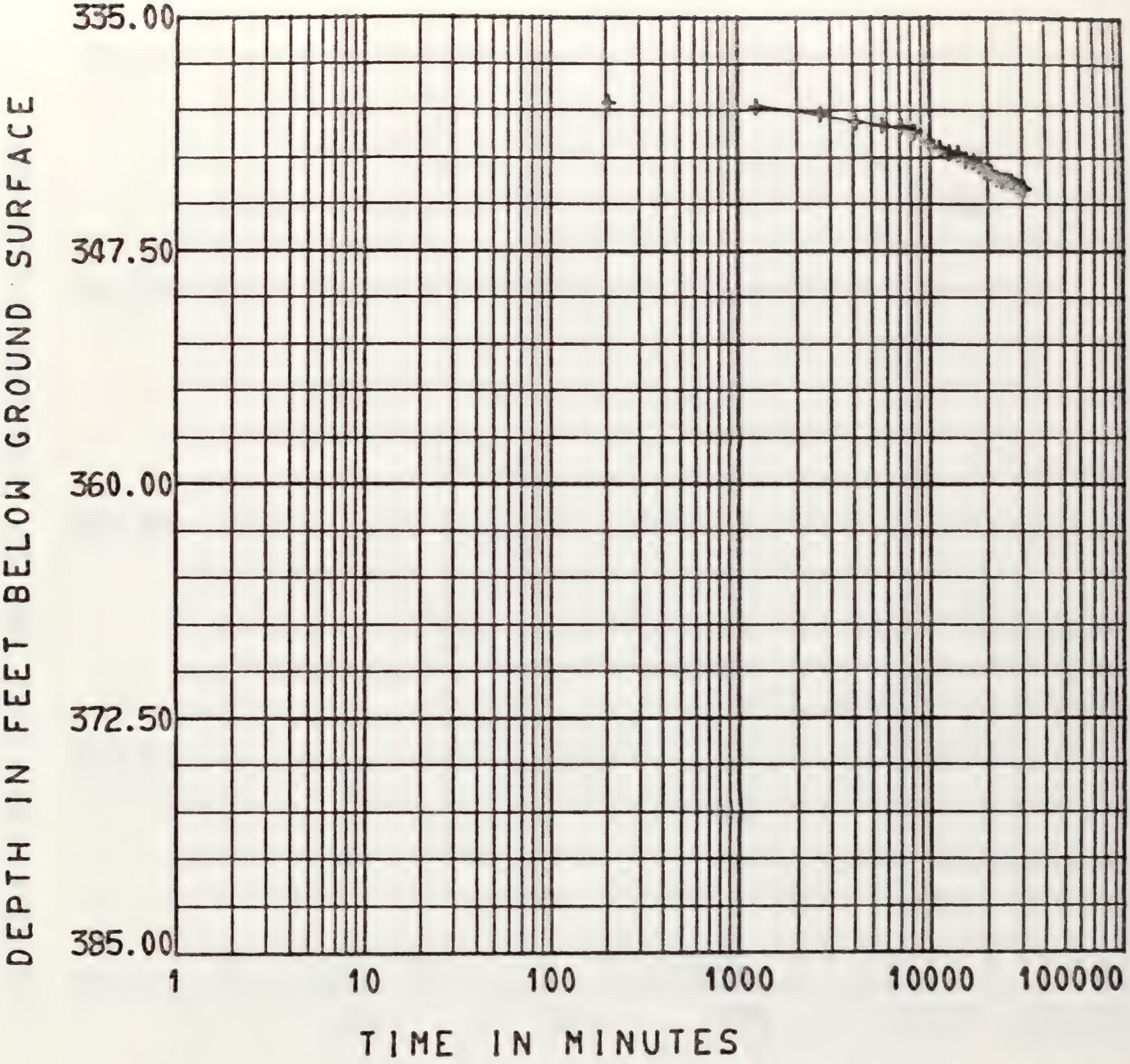
GS-13 GS-19 LOWR RECOVERY



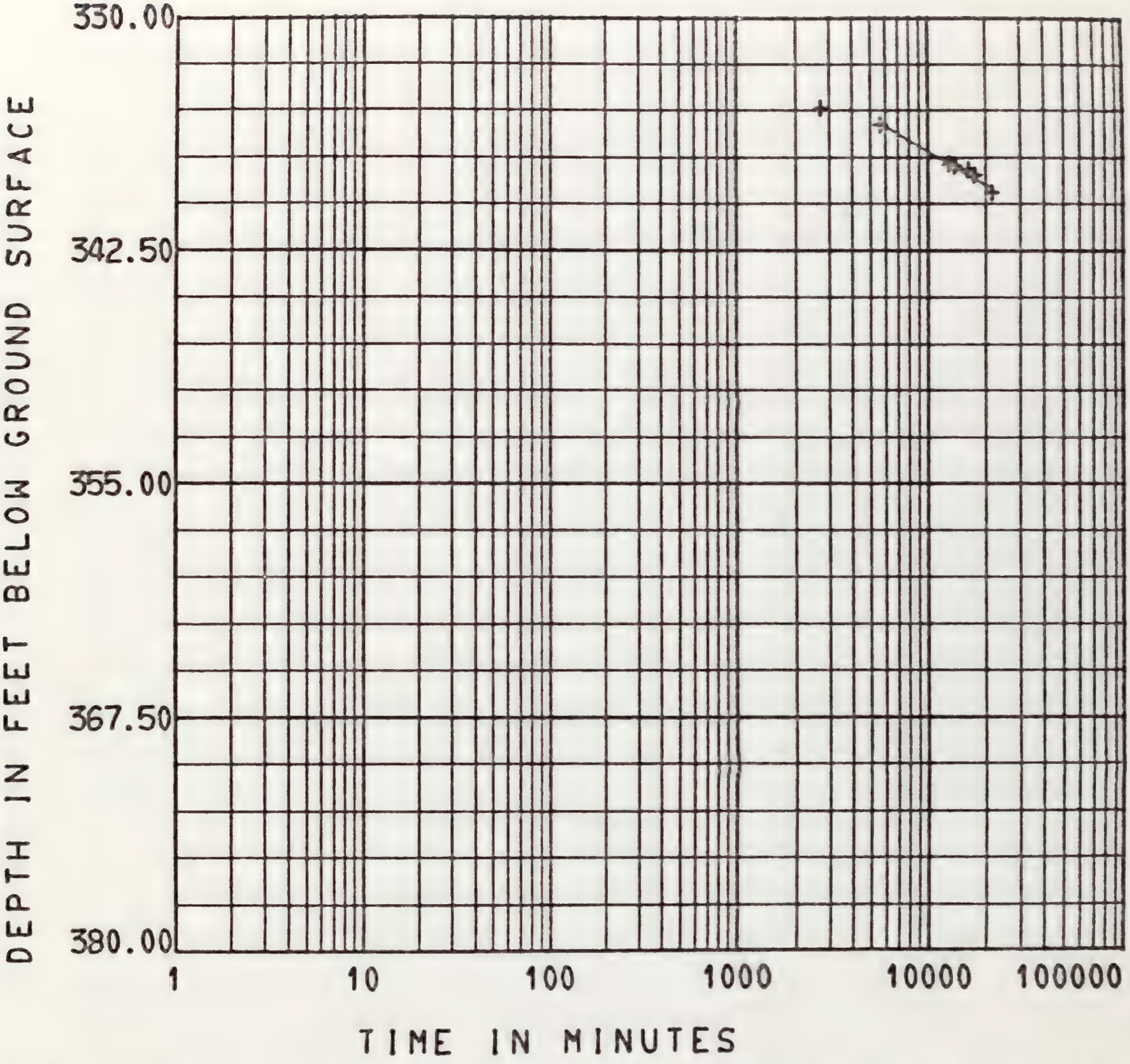
GS-13 GS-19 LOWR DRAWDOWN



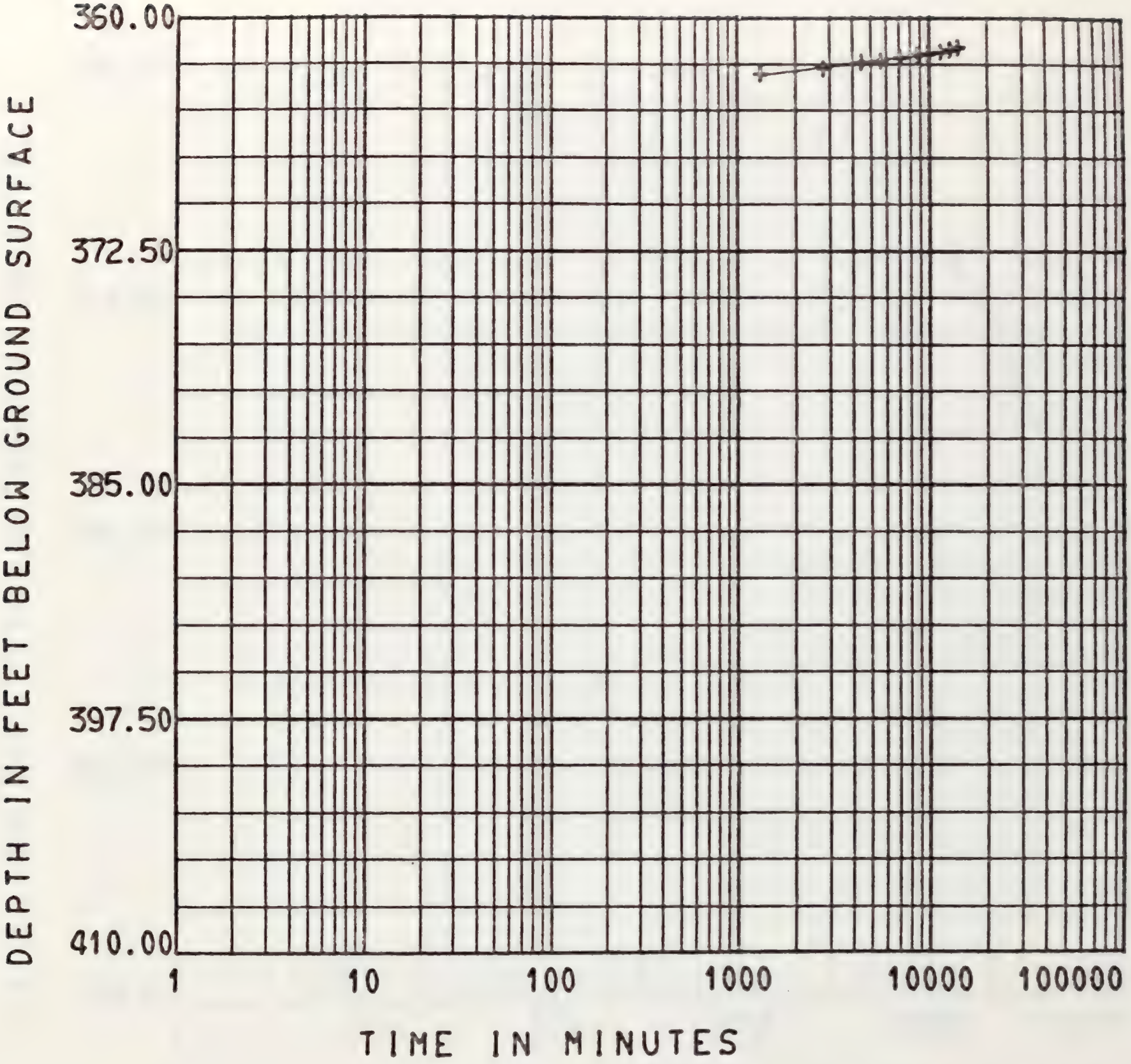
GS-13 GS-19 LOWR RECOVERY



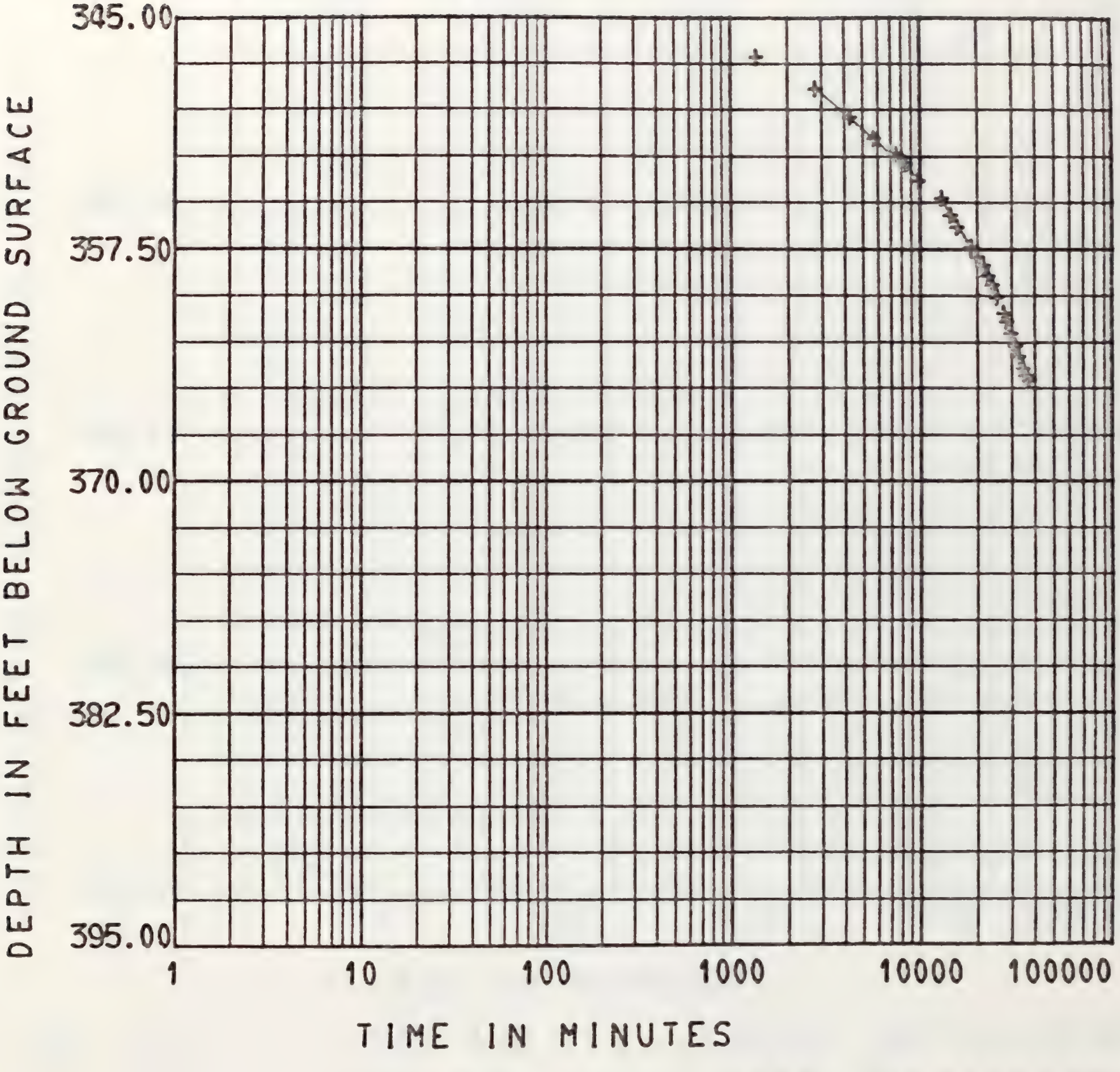
GS-15 GS-16 LOWR DRAWDOWN



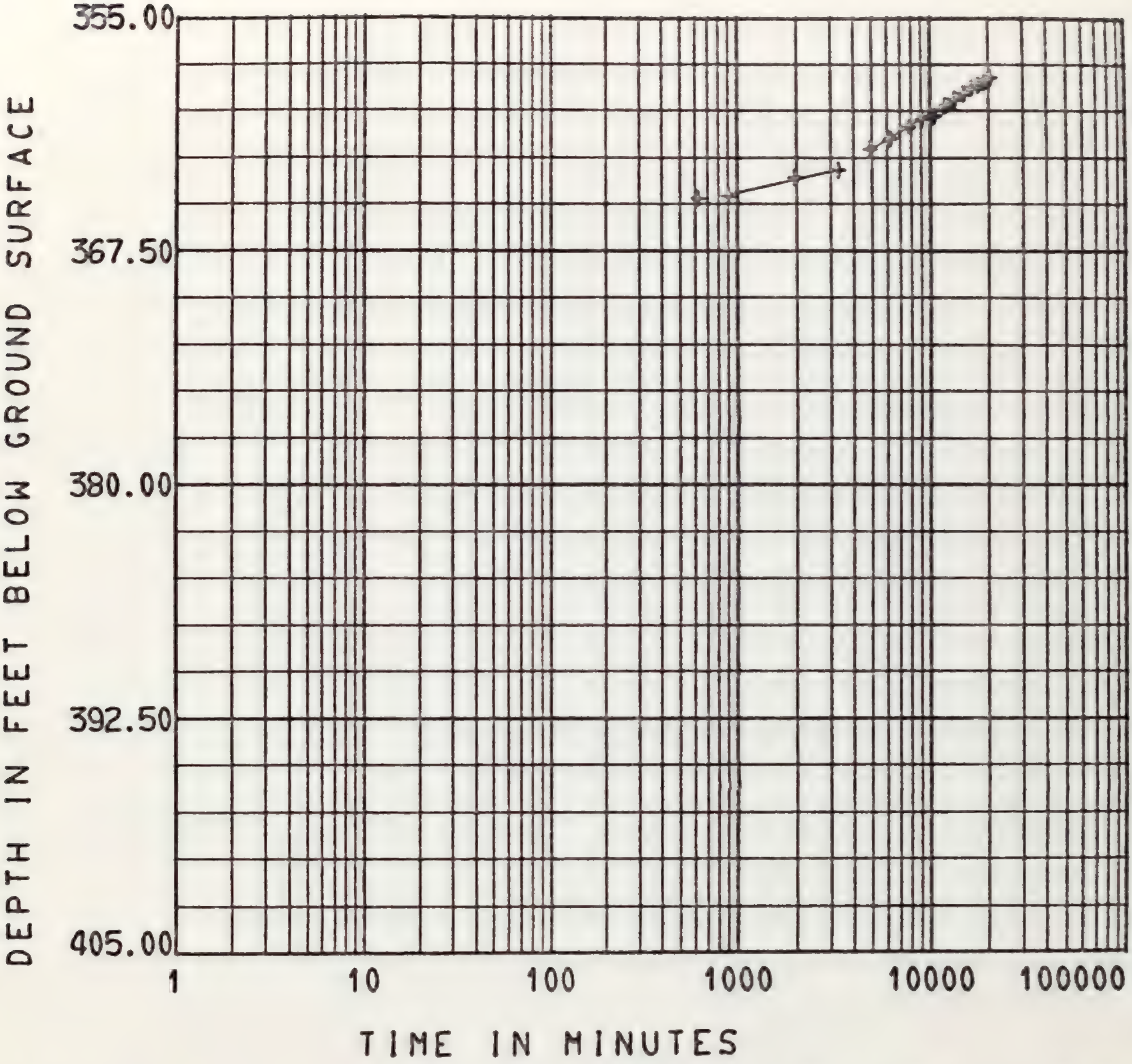
GS-15 GS-17 LOWR DRAWDOWN



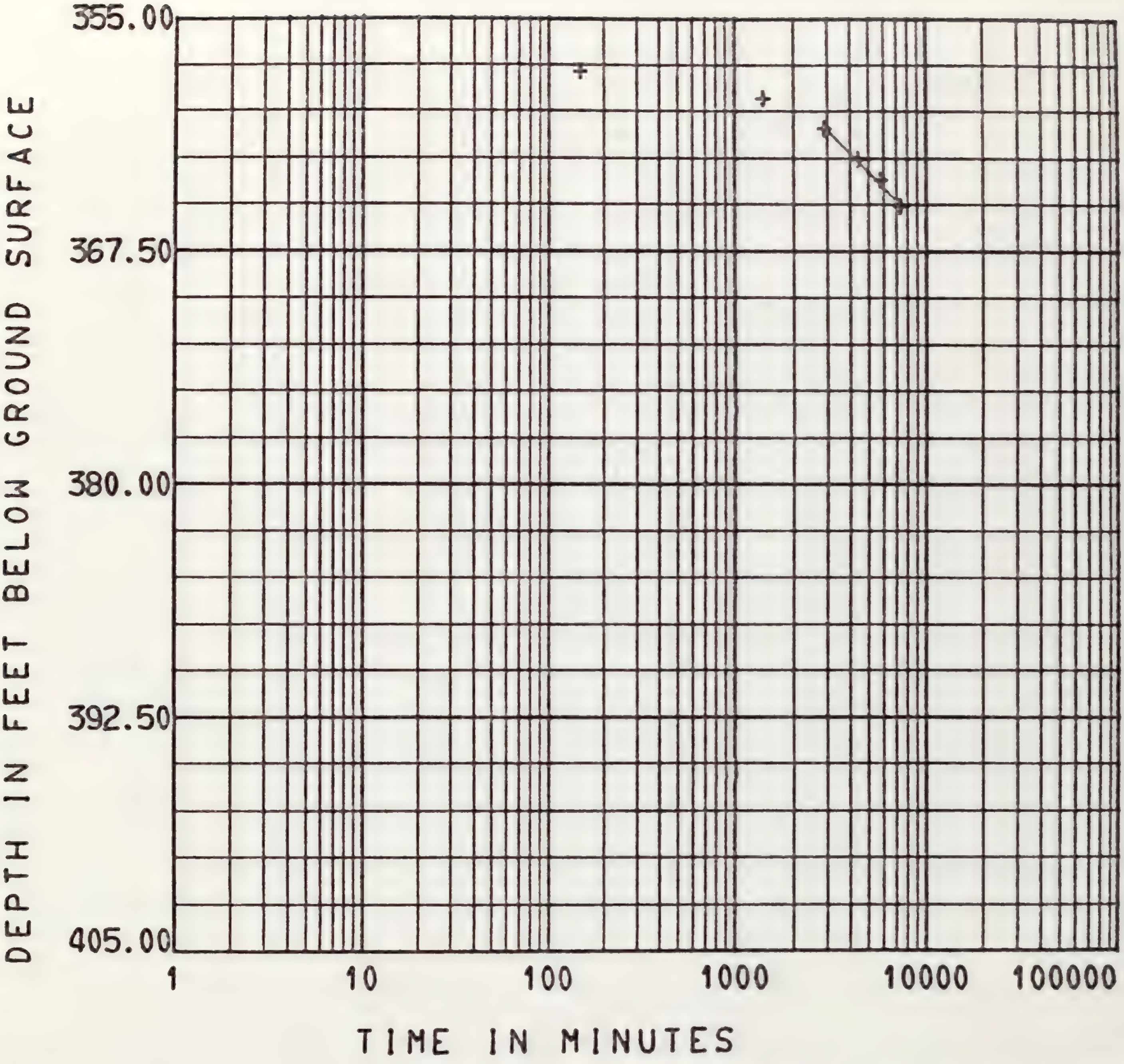
GS-15 GS-18 LOWR RECOVERY



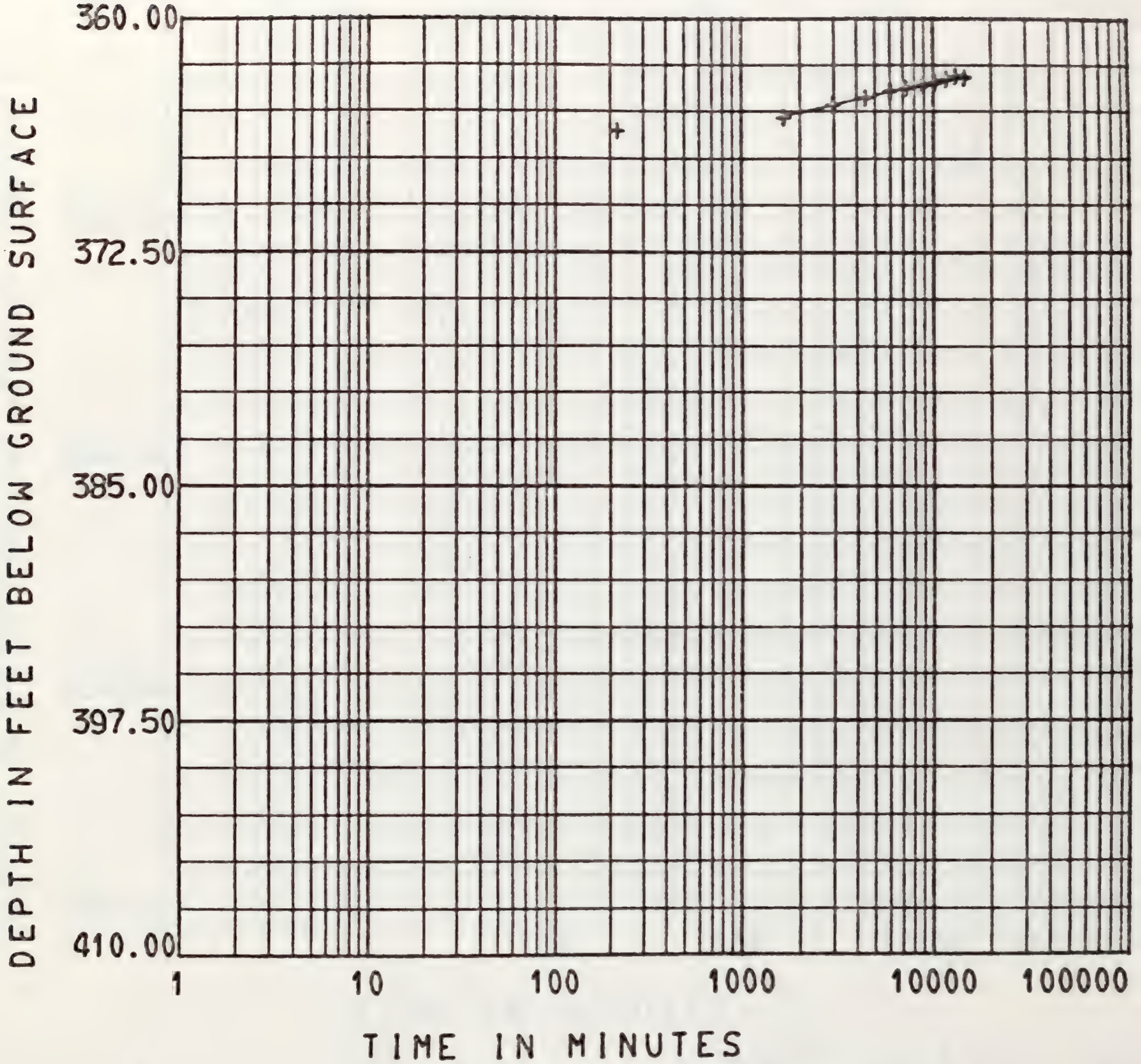
GS-15 GS-19 LOWR DRAWDOWN



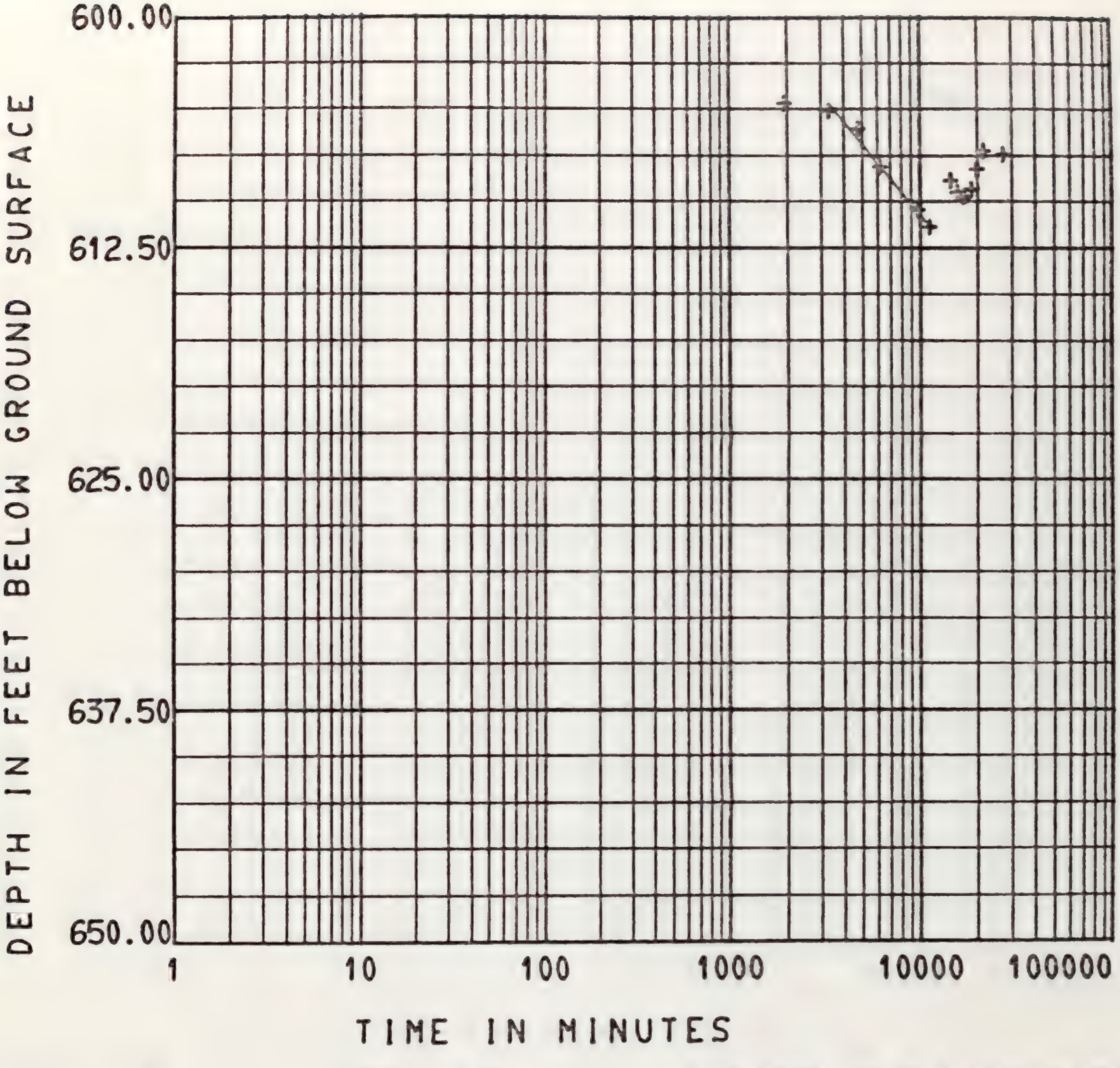
GS-15 GS-19 LOWR RECOVERY



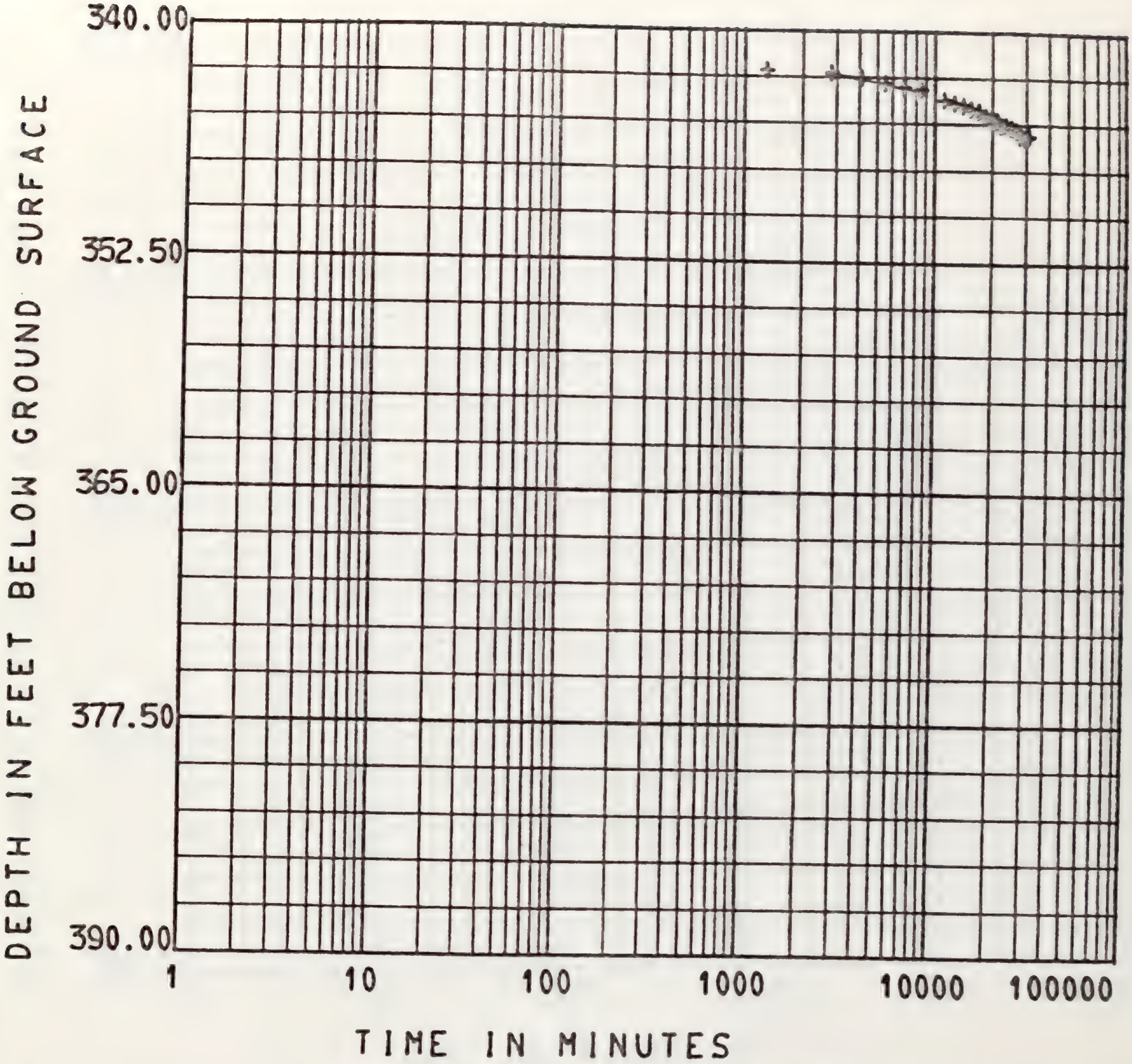
GS-15 GS-19 LOWR DRAWDOWN



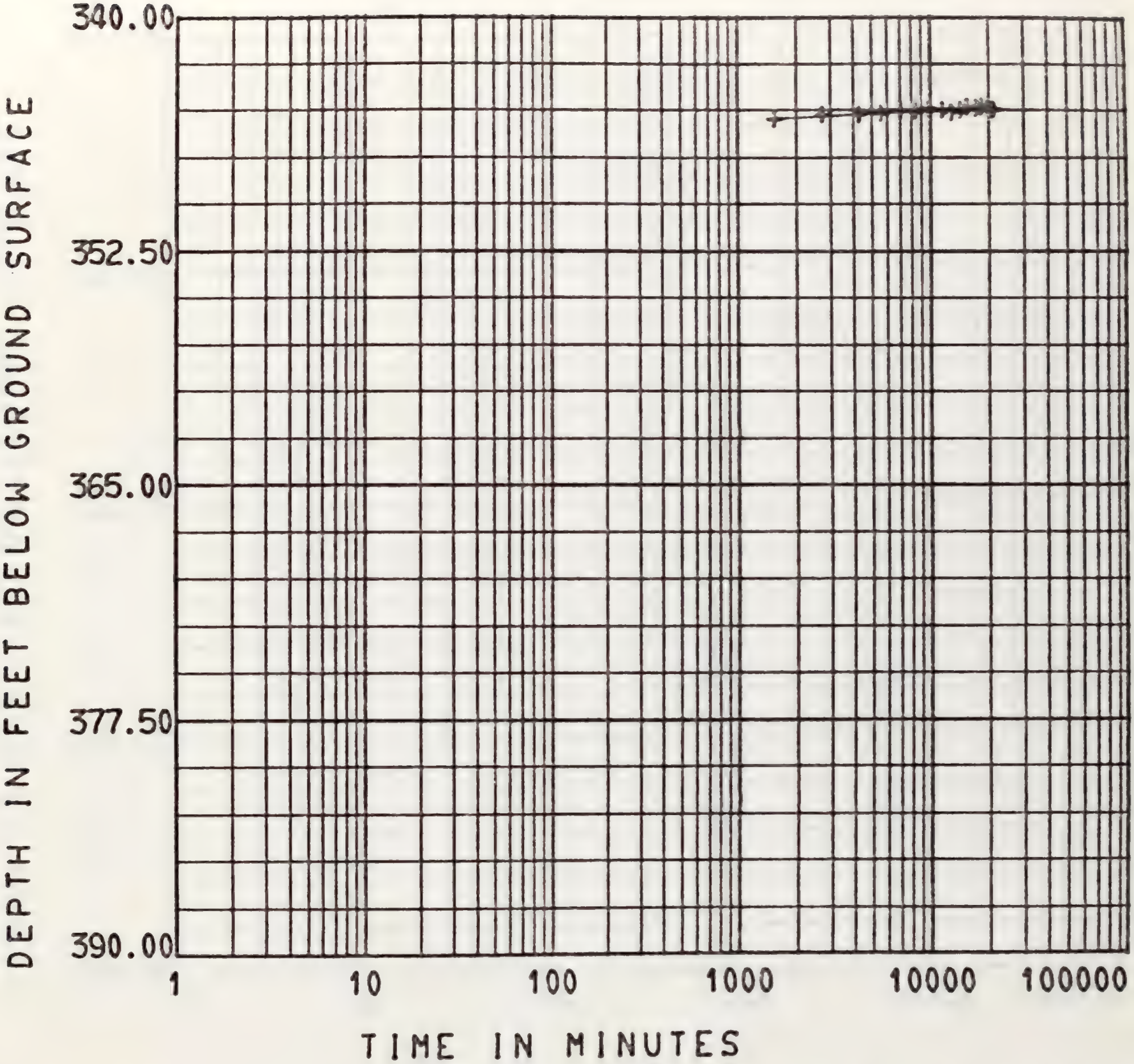
GS-15 GS-19 LOWR RECOVERY



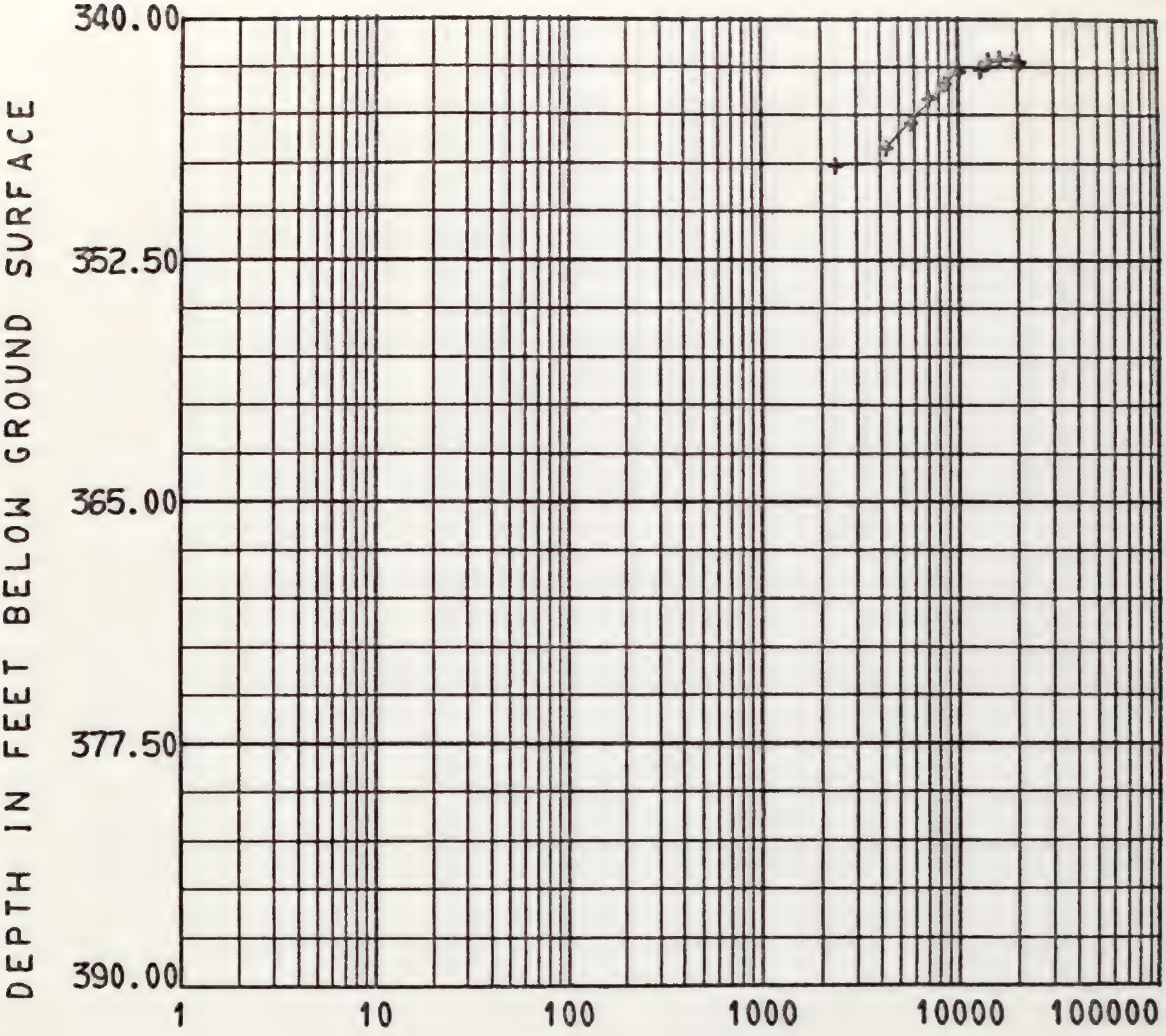
GS-16 GS-19 LOWR DRAWDOWN



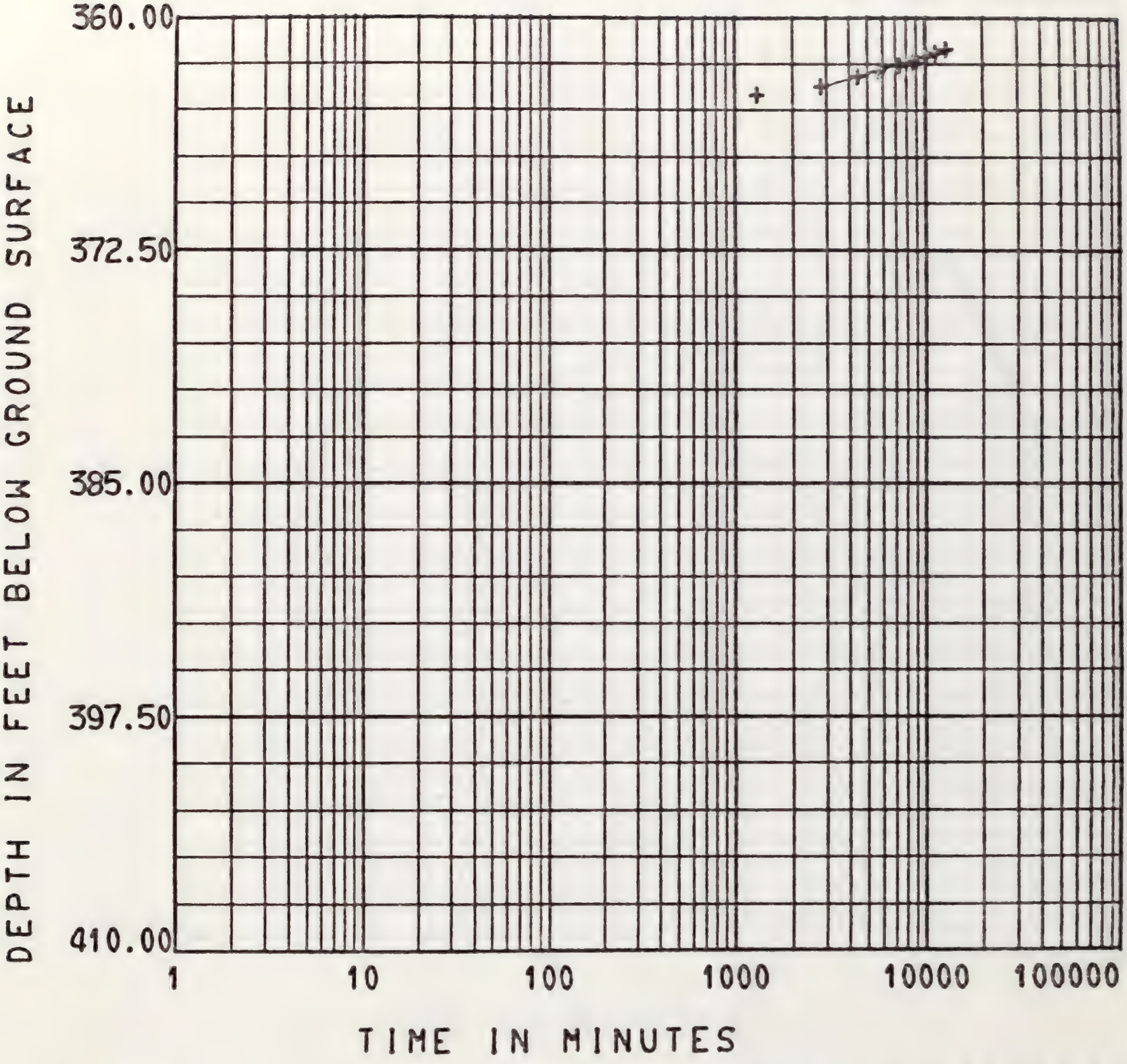
GS-17 GS-16 LOWR DRAWDOWN



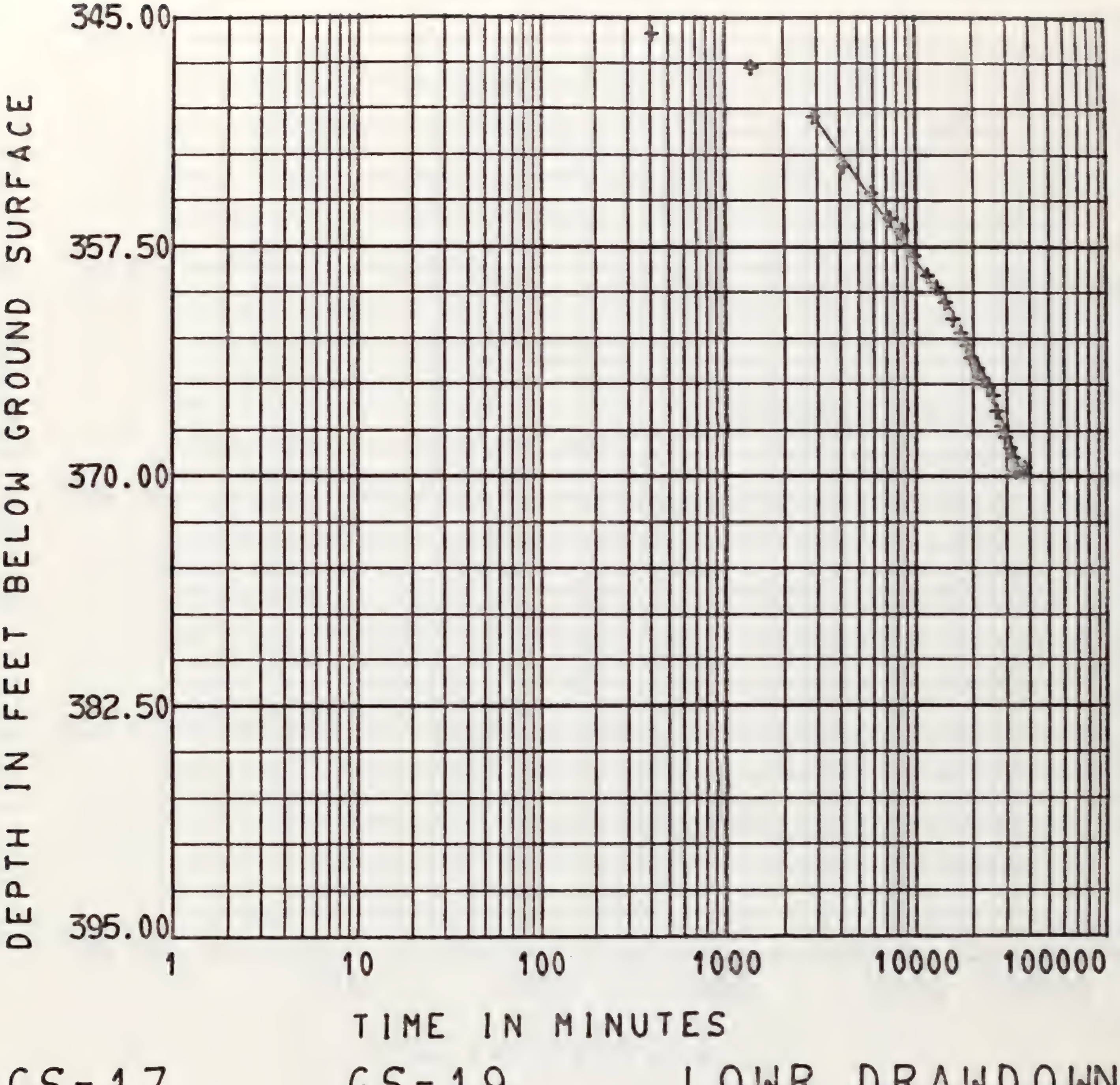
GS-17 GS-16 LOWR RECOVERY



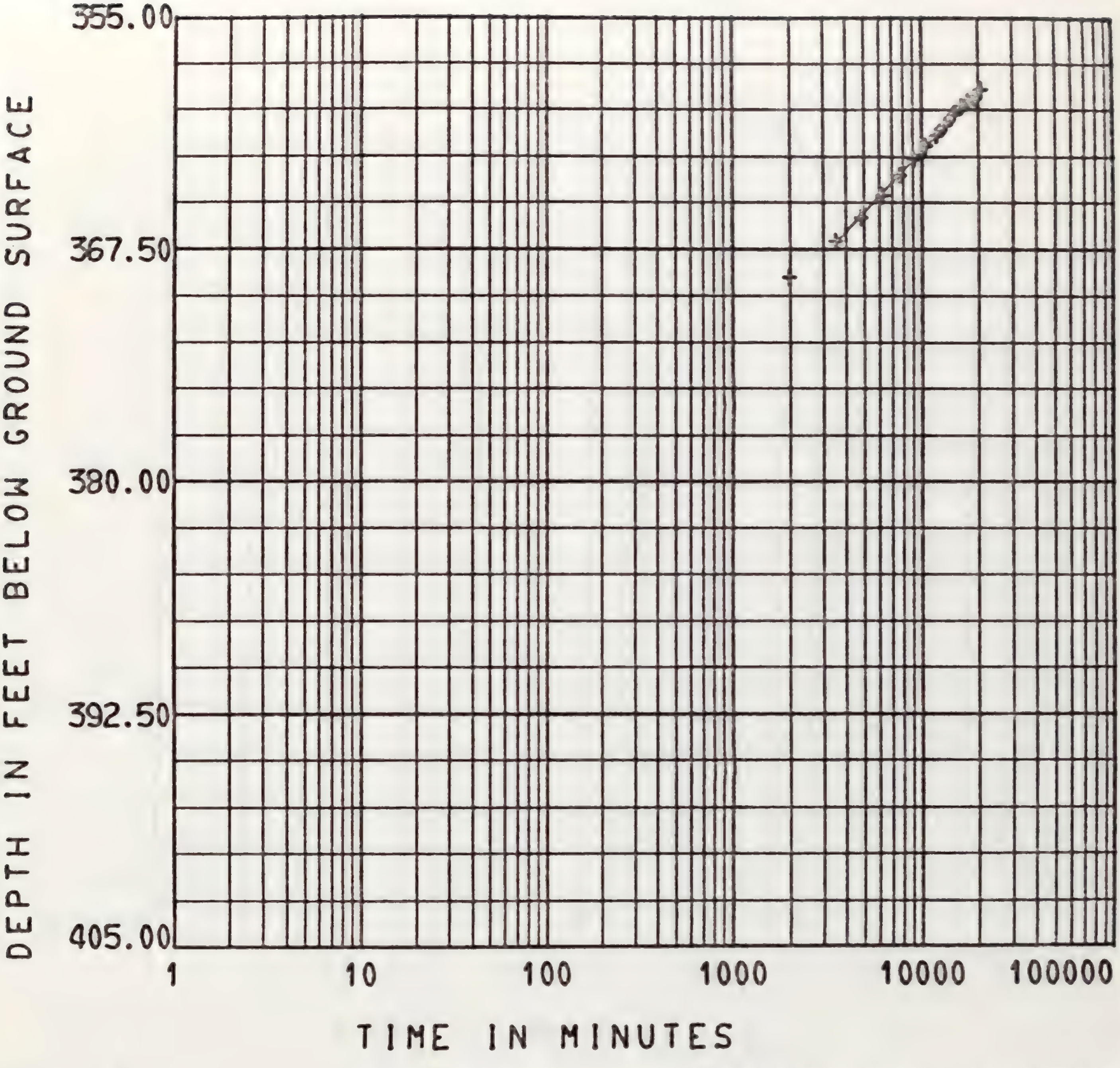
GS-17 GS-17 LOWR RECOVERY



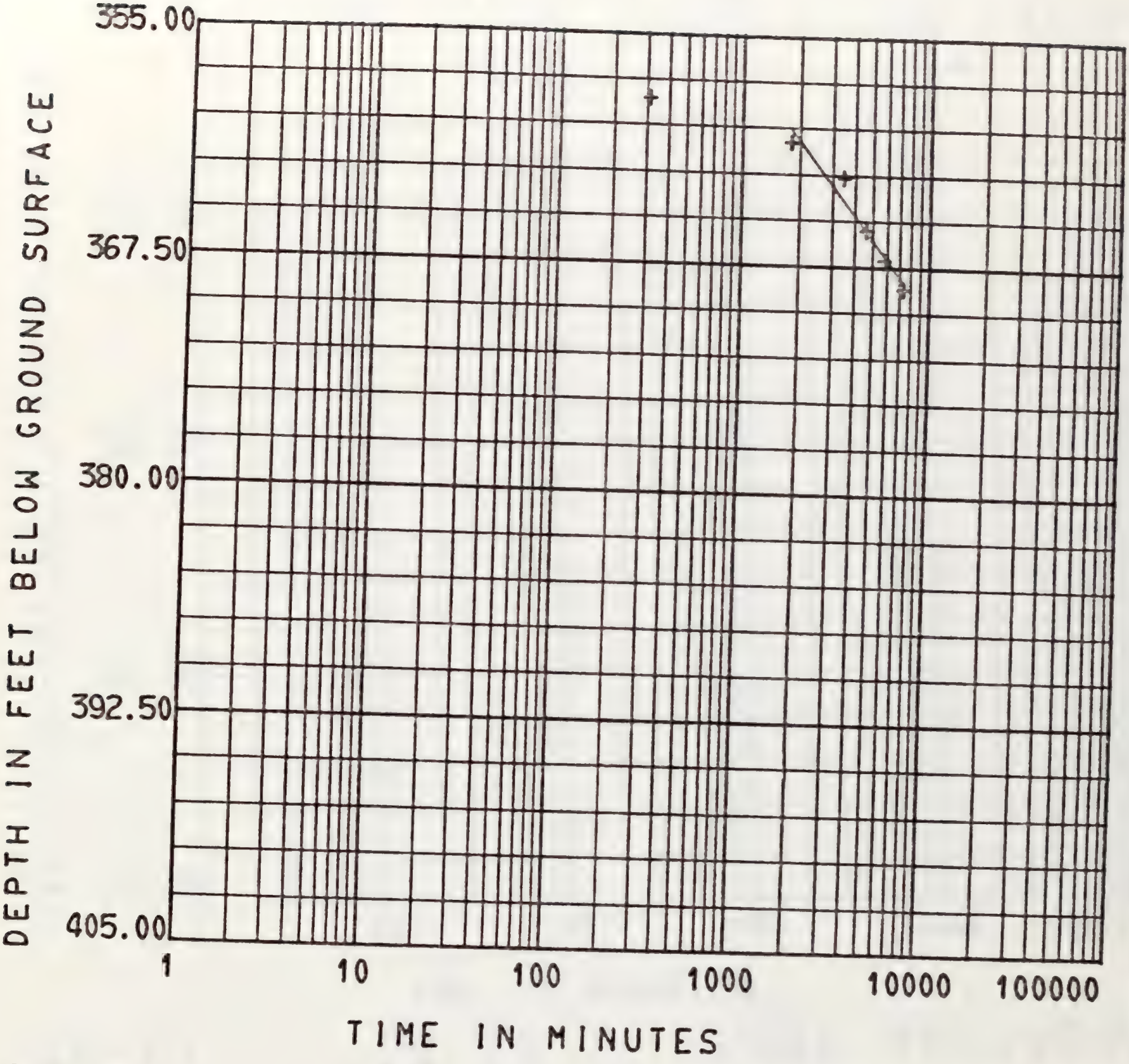
GS-17 GS-18 LOWR RECOVERY



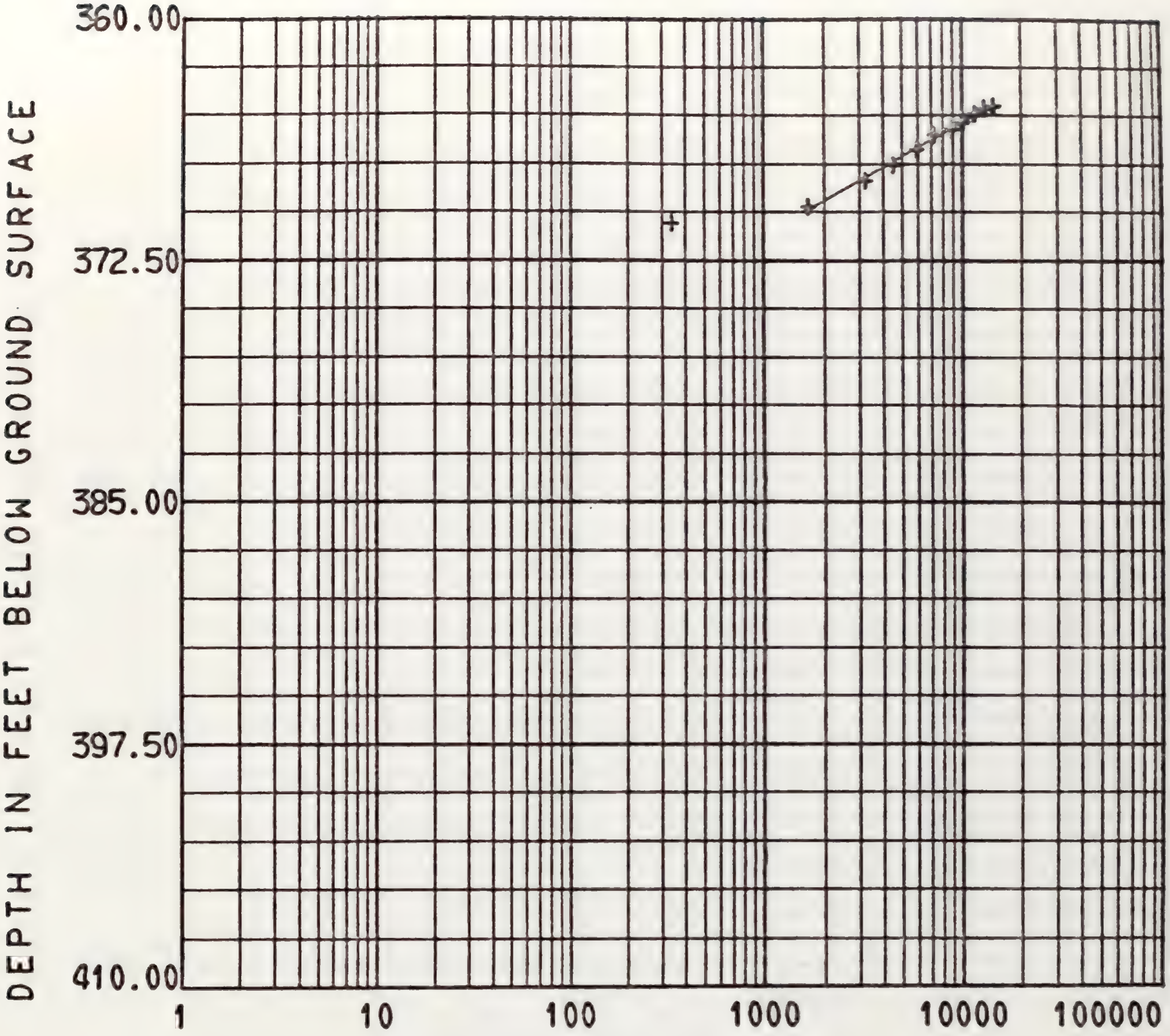
GS-17 GS-19 LOWR DRAWDOWN



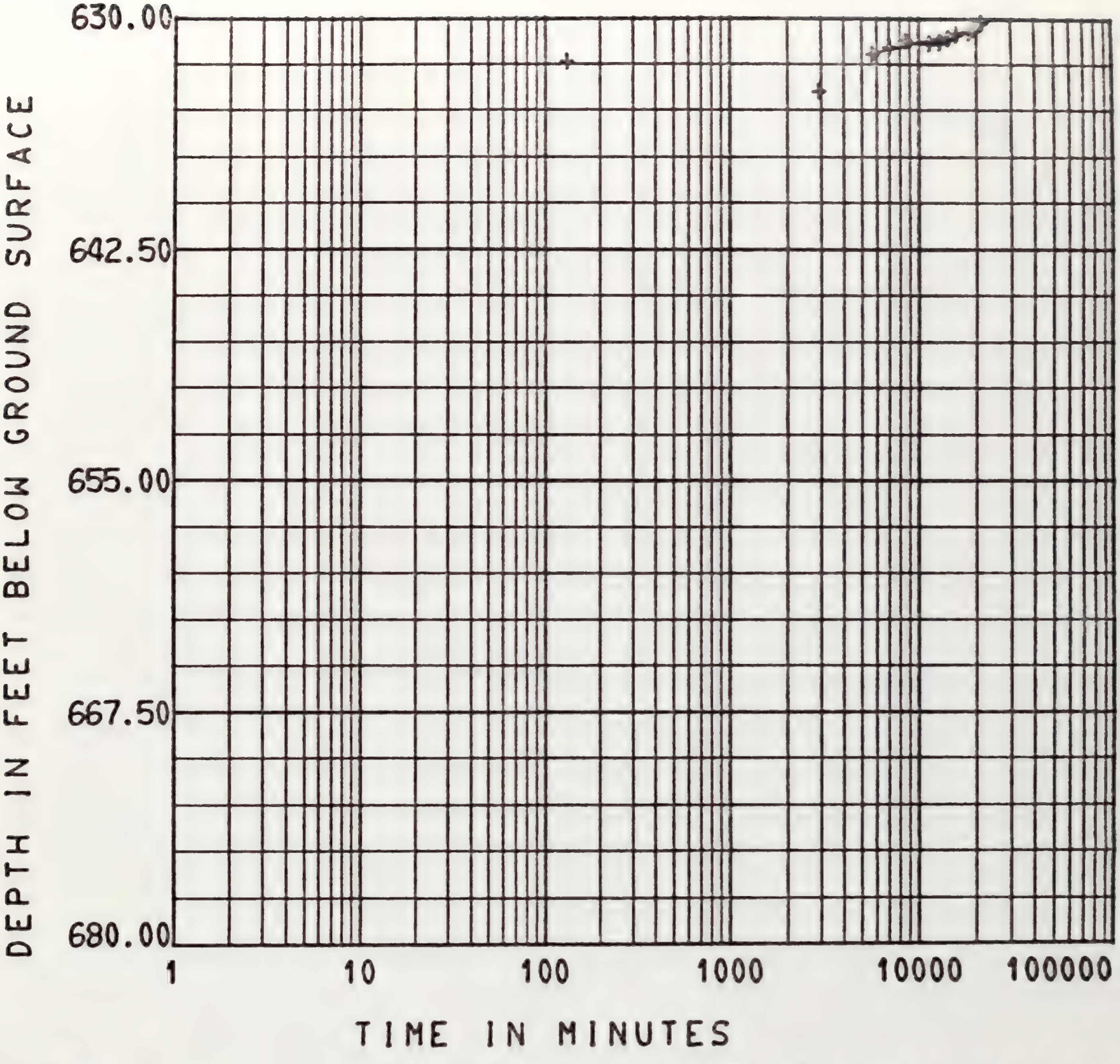
GS-17 GS-19 LOWR RECOVERY



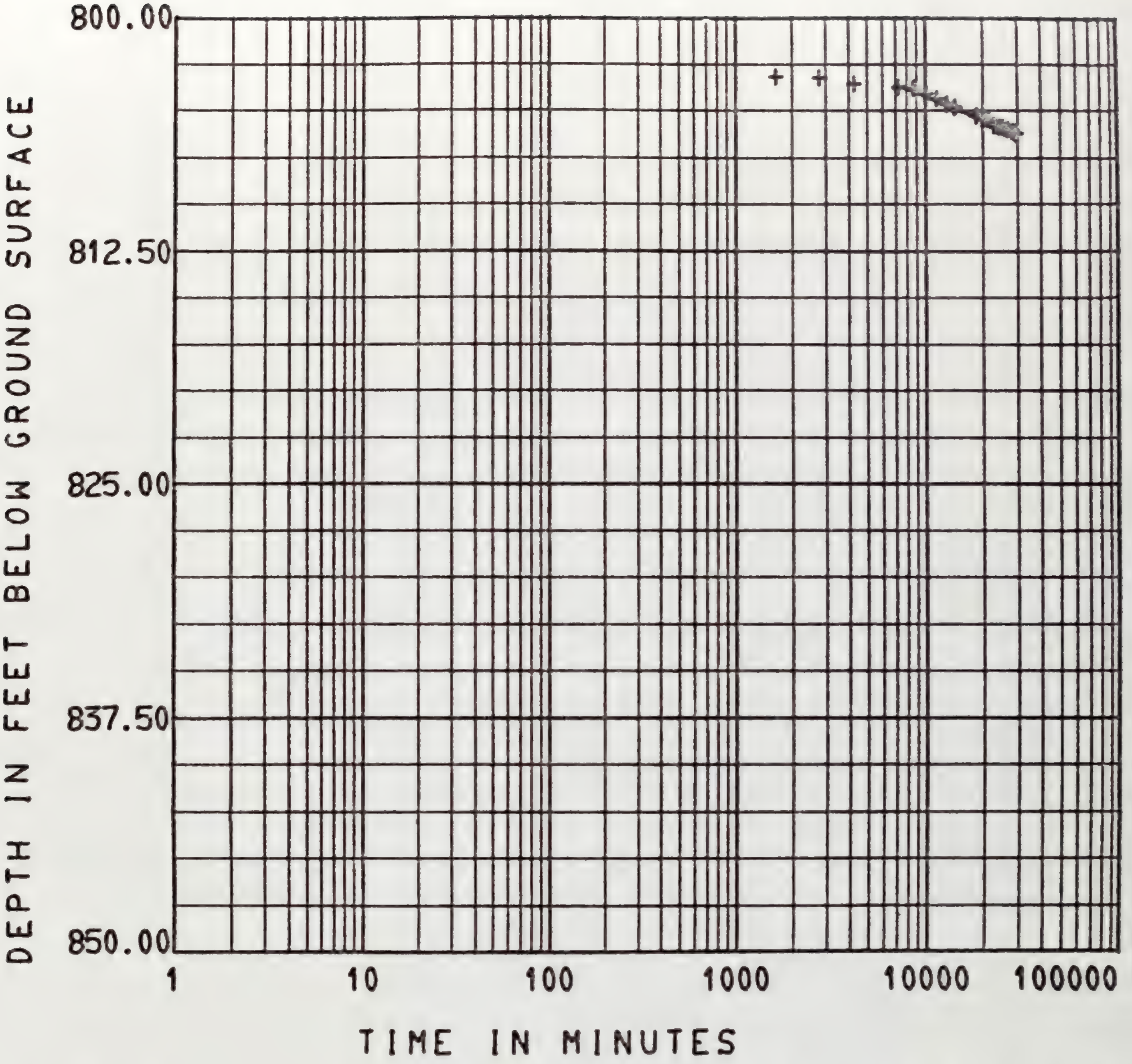
GS-17 GS-19 LOWR DRAWDOWN



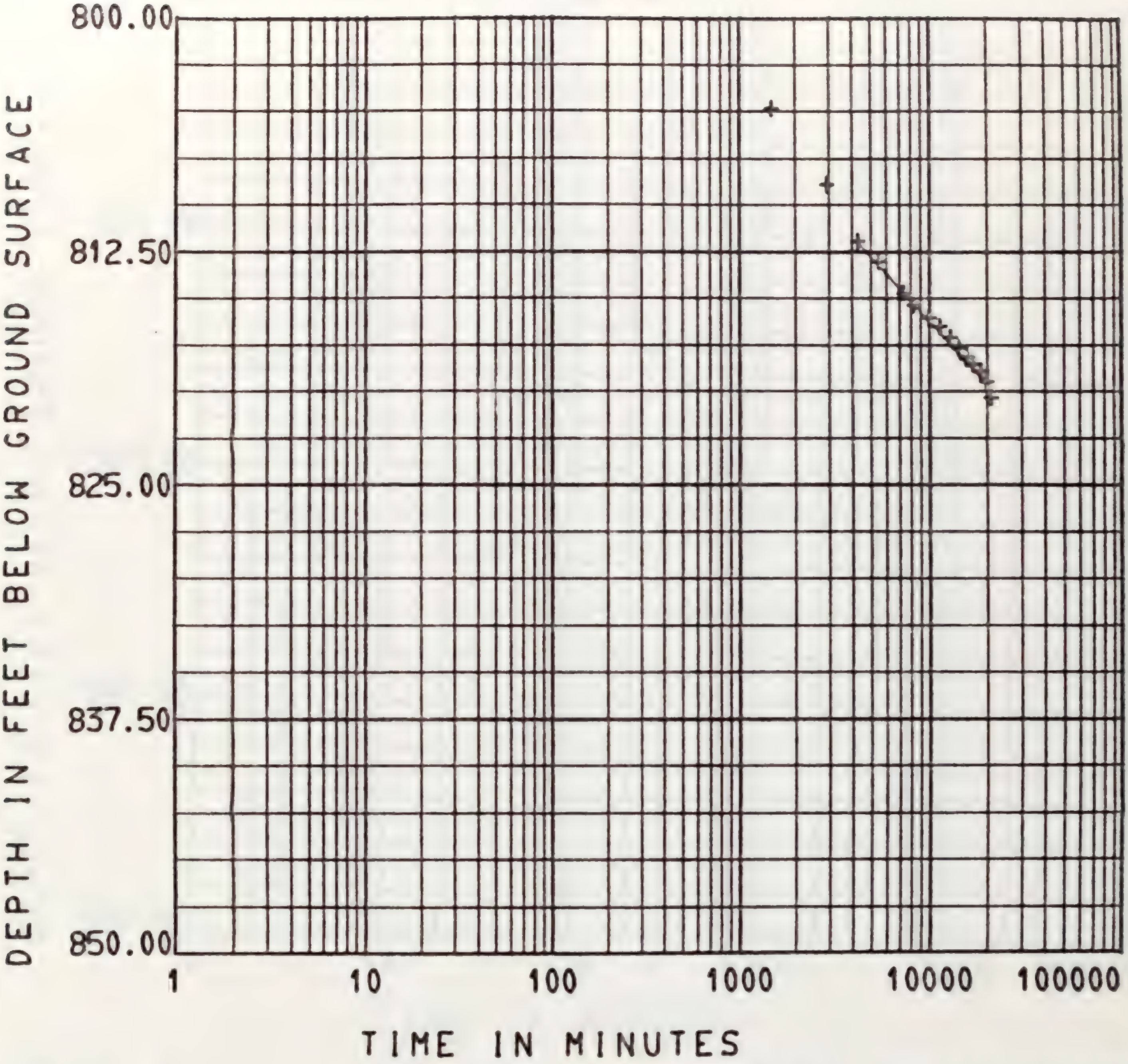
GS-17 GS-19 LOWR RECOVERY



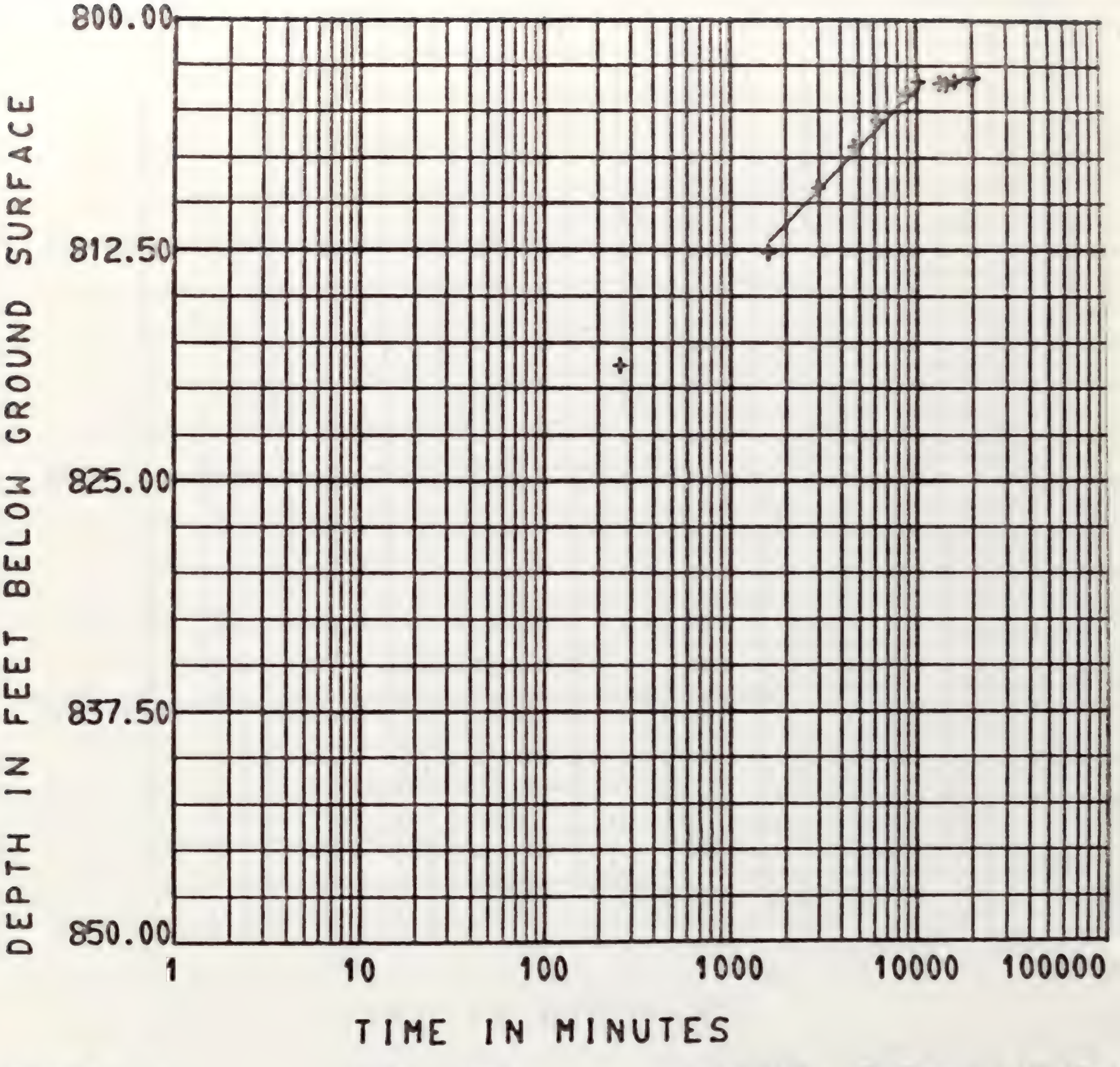
GSM-1 CE 705A UPPR RECOVERY



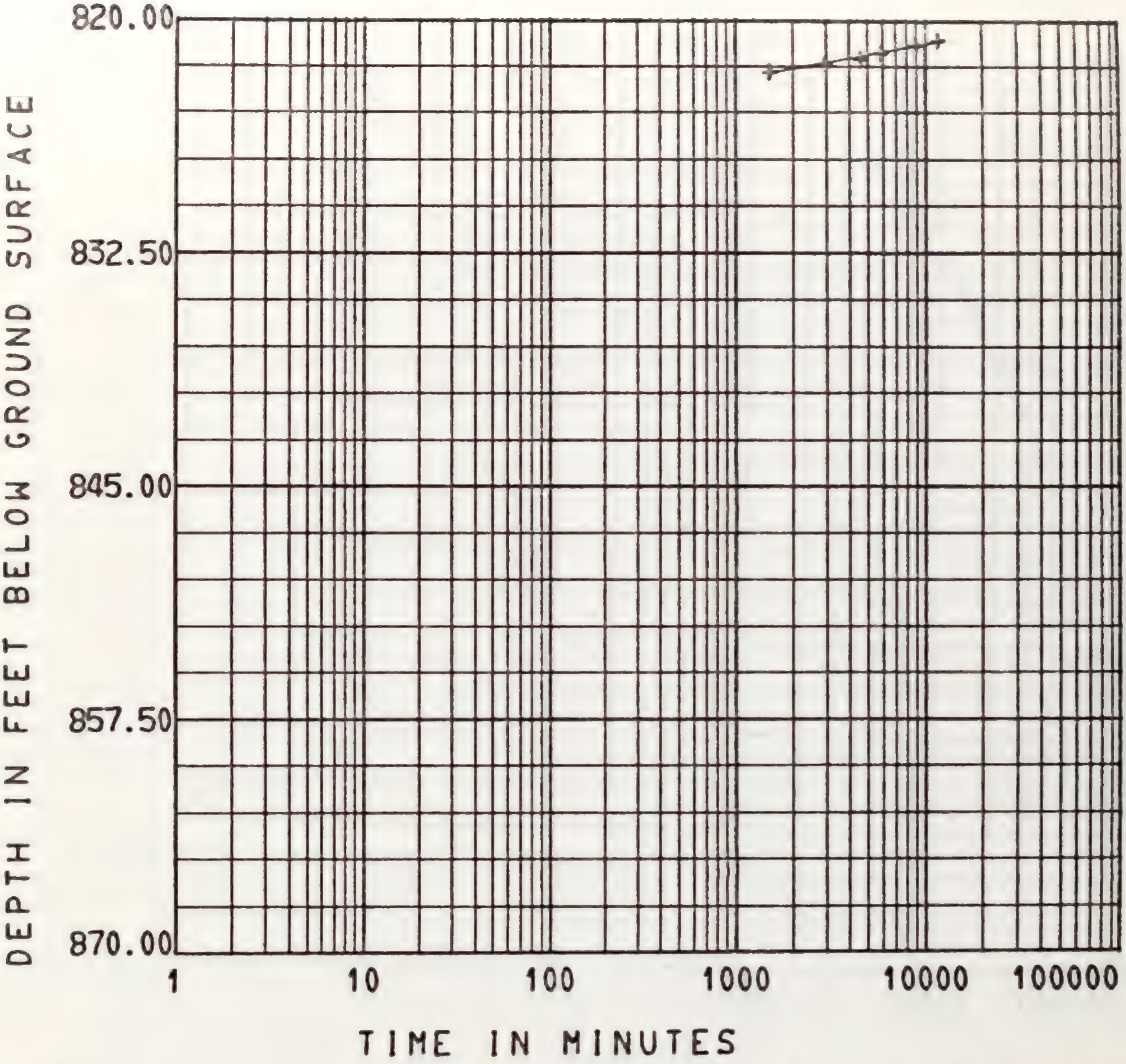
GSM-1 GS-16 LOWR DRAWDOWN



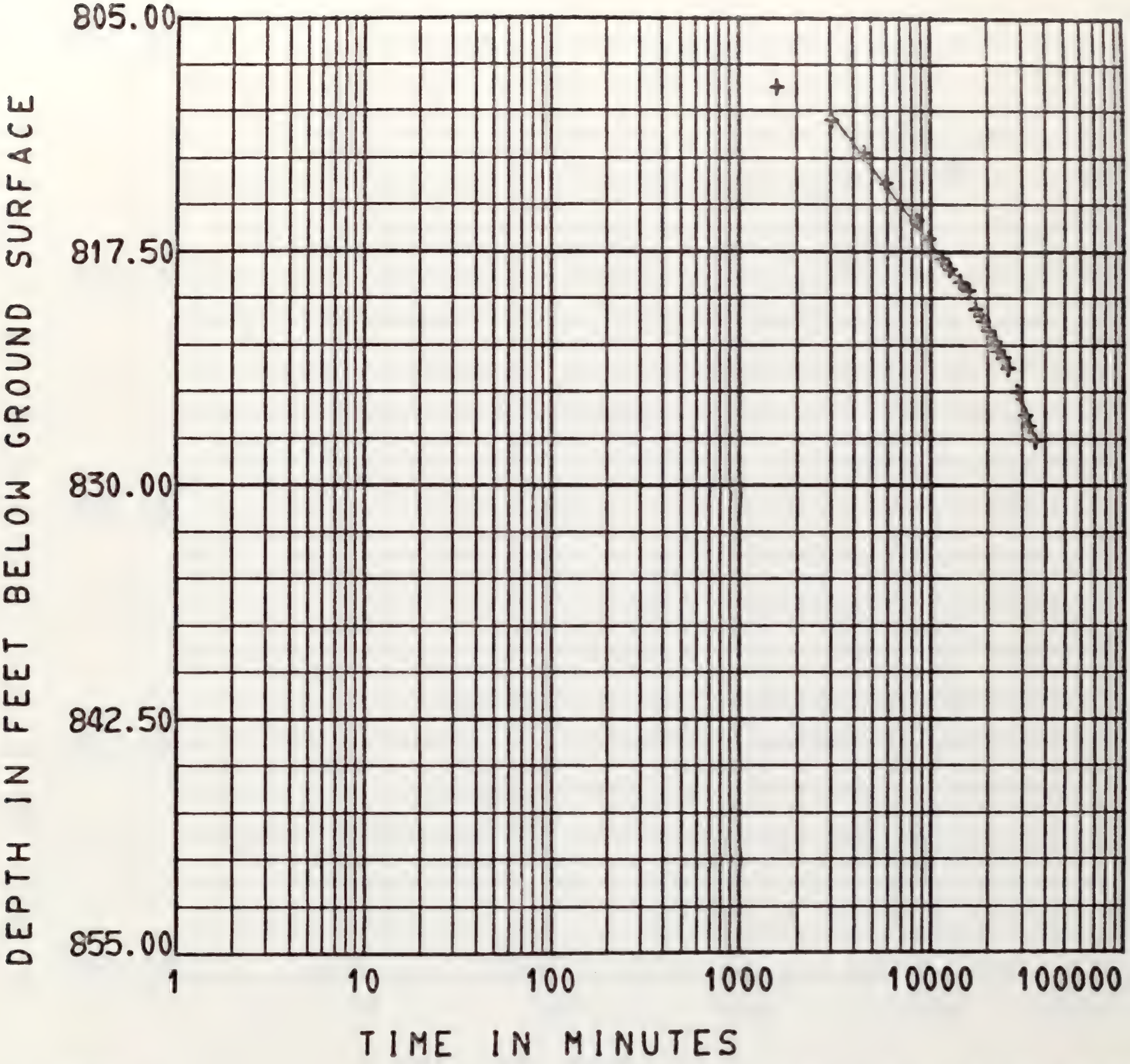
GSM-1 GS-17 LOWR DRAWDOWN



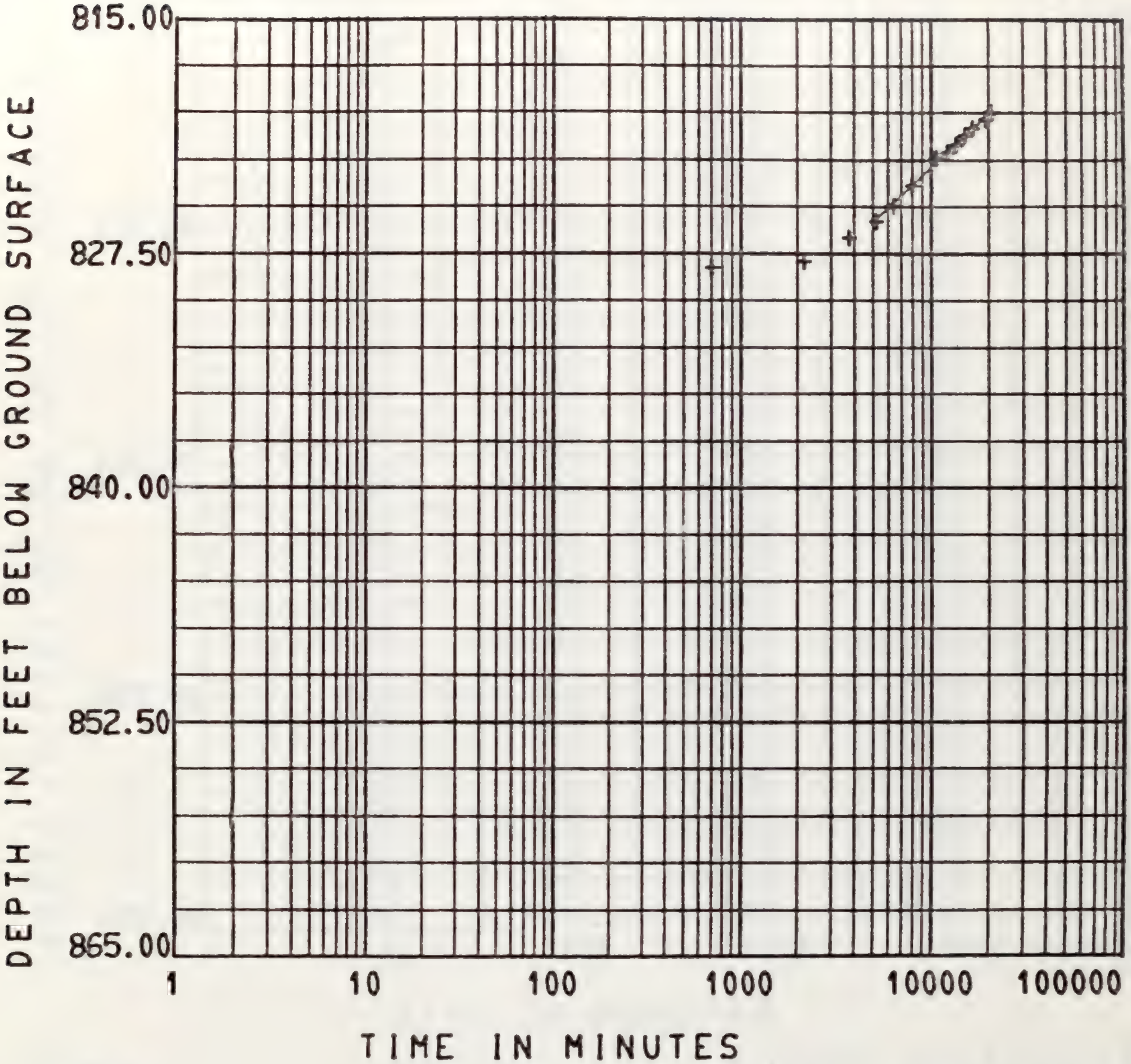
GSM-1 GS-17 LOWR RECOVERY



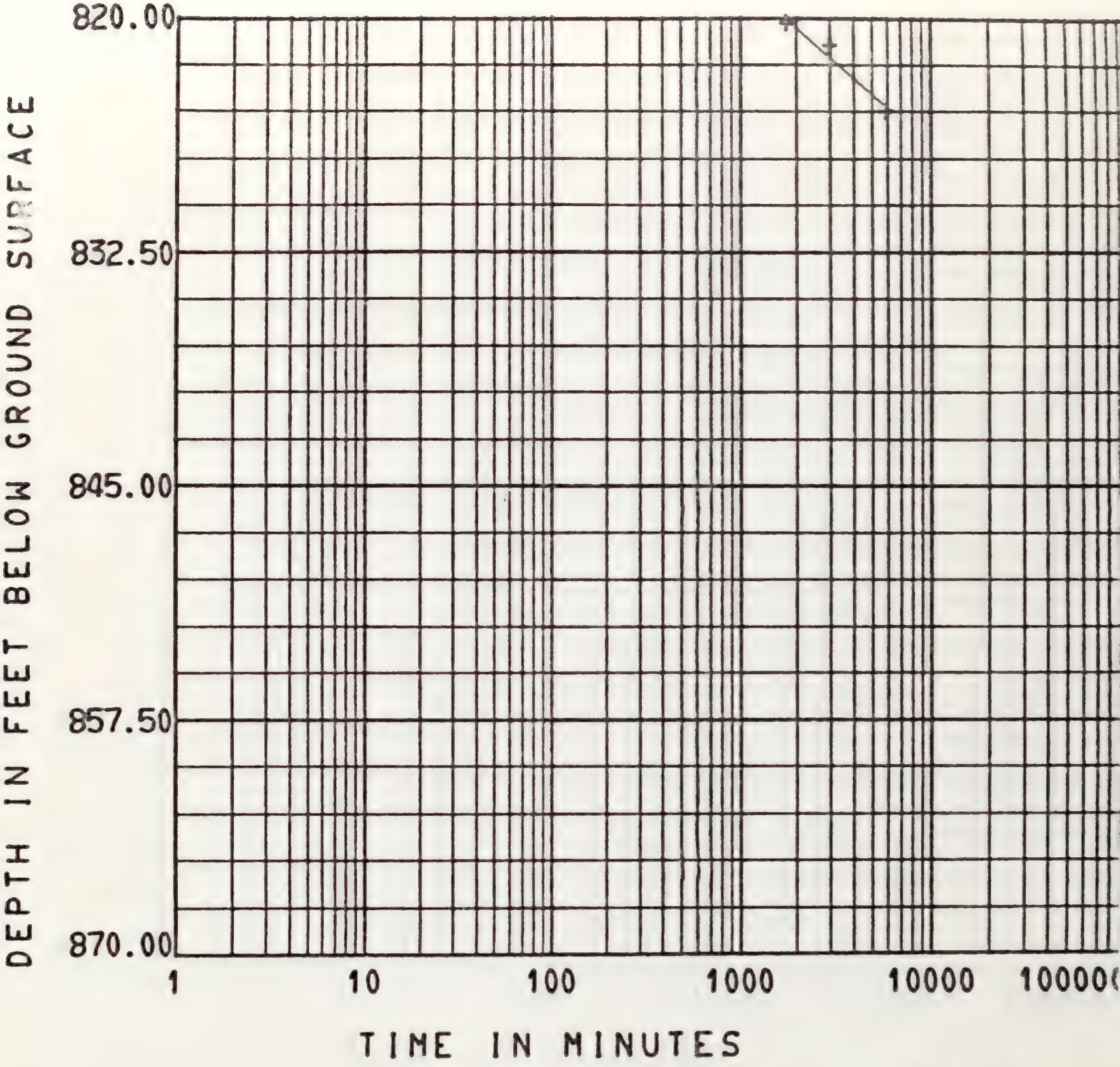
GSM-1 GS-18 LOWR RECOVERY



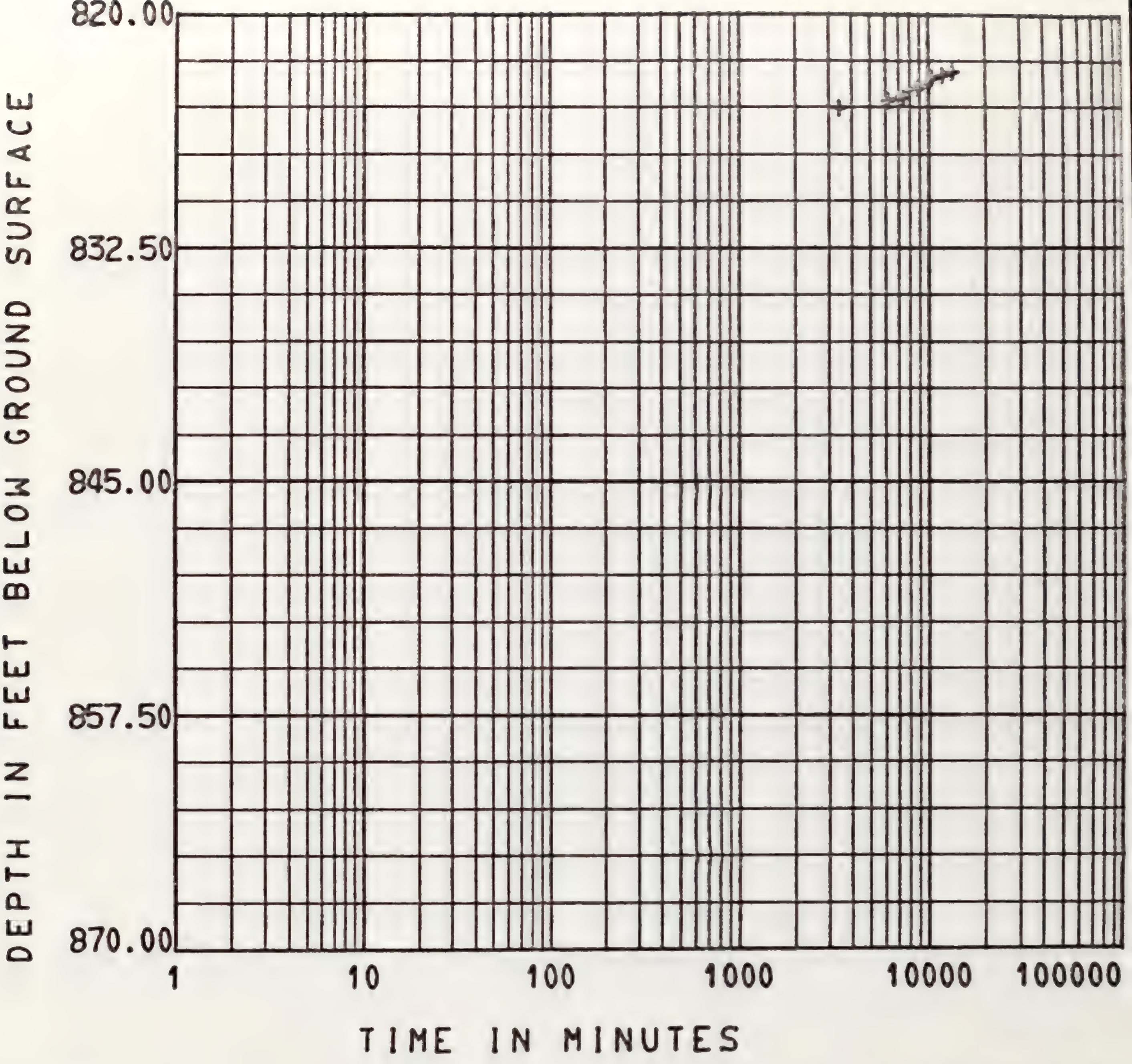
GSM-1 GS-19 LOWR DRAWDOWN



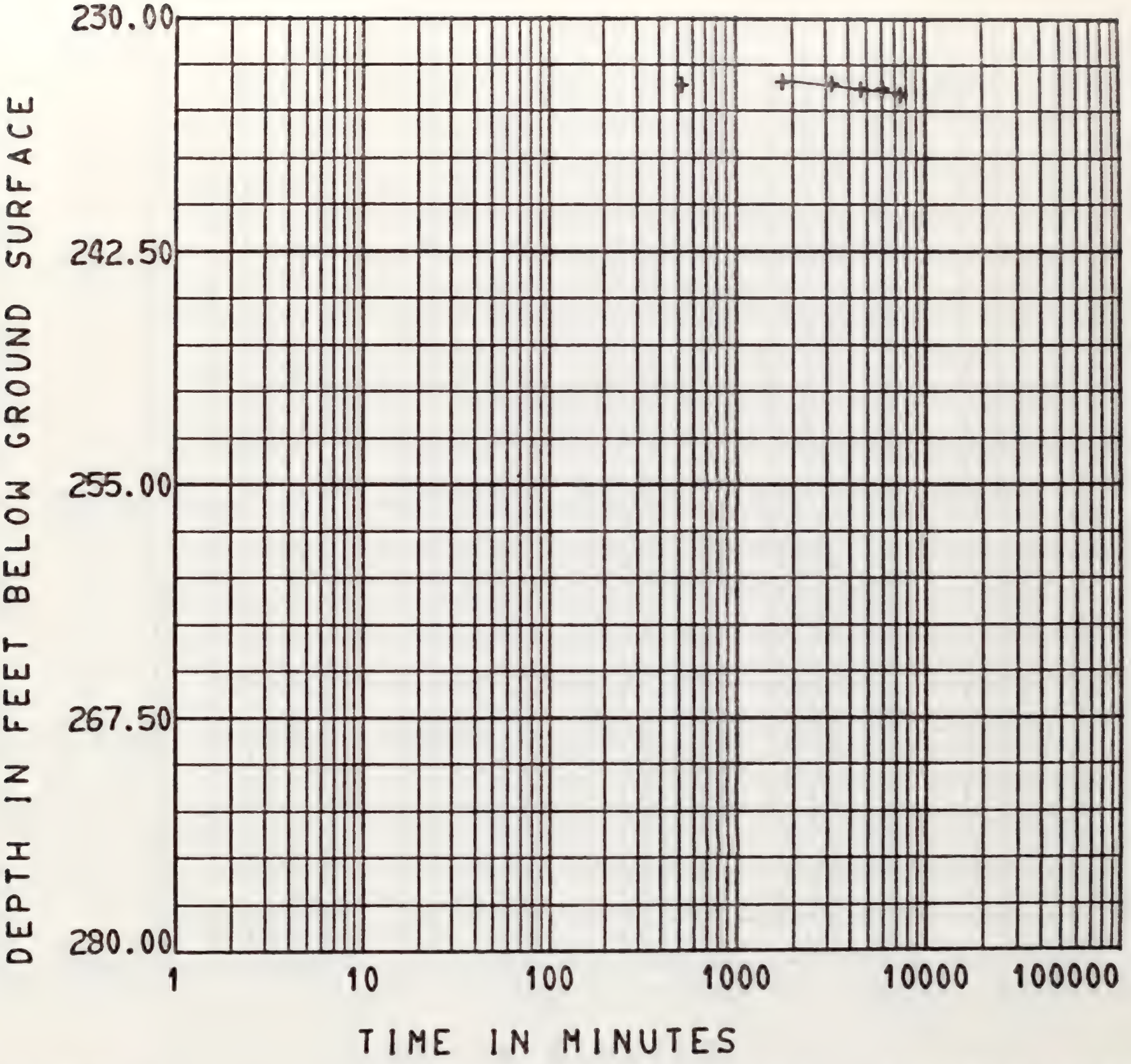
GSM-1 GS-19 LOWR RECOVERY



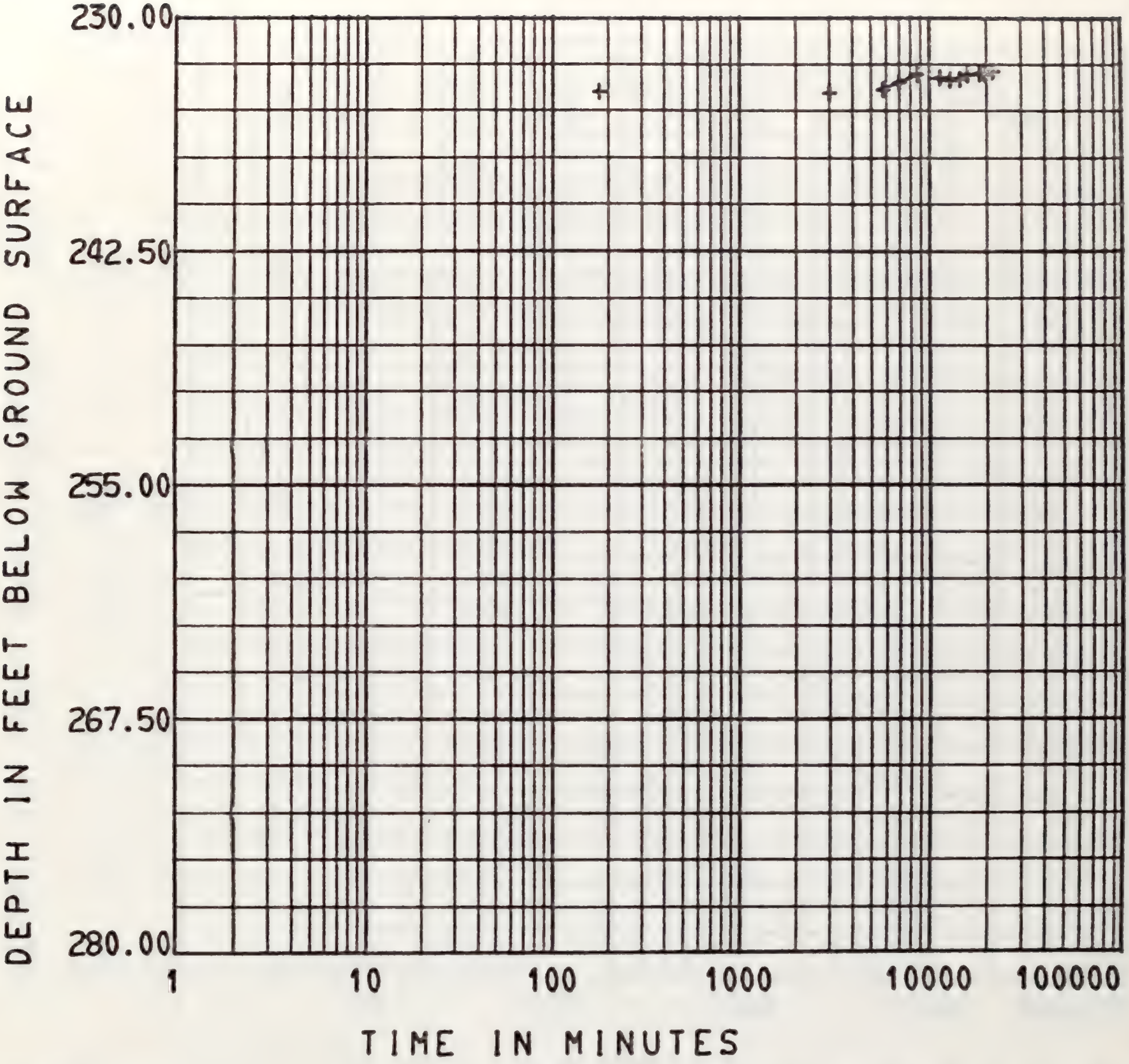
GSM-1 GS-19 LOWR DRAWDOW



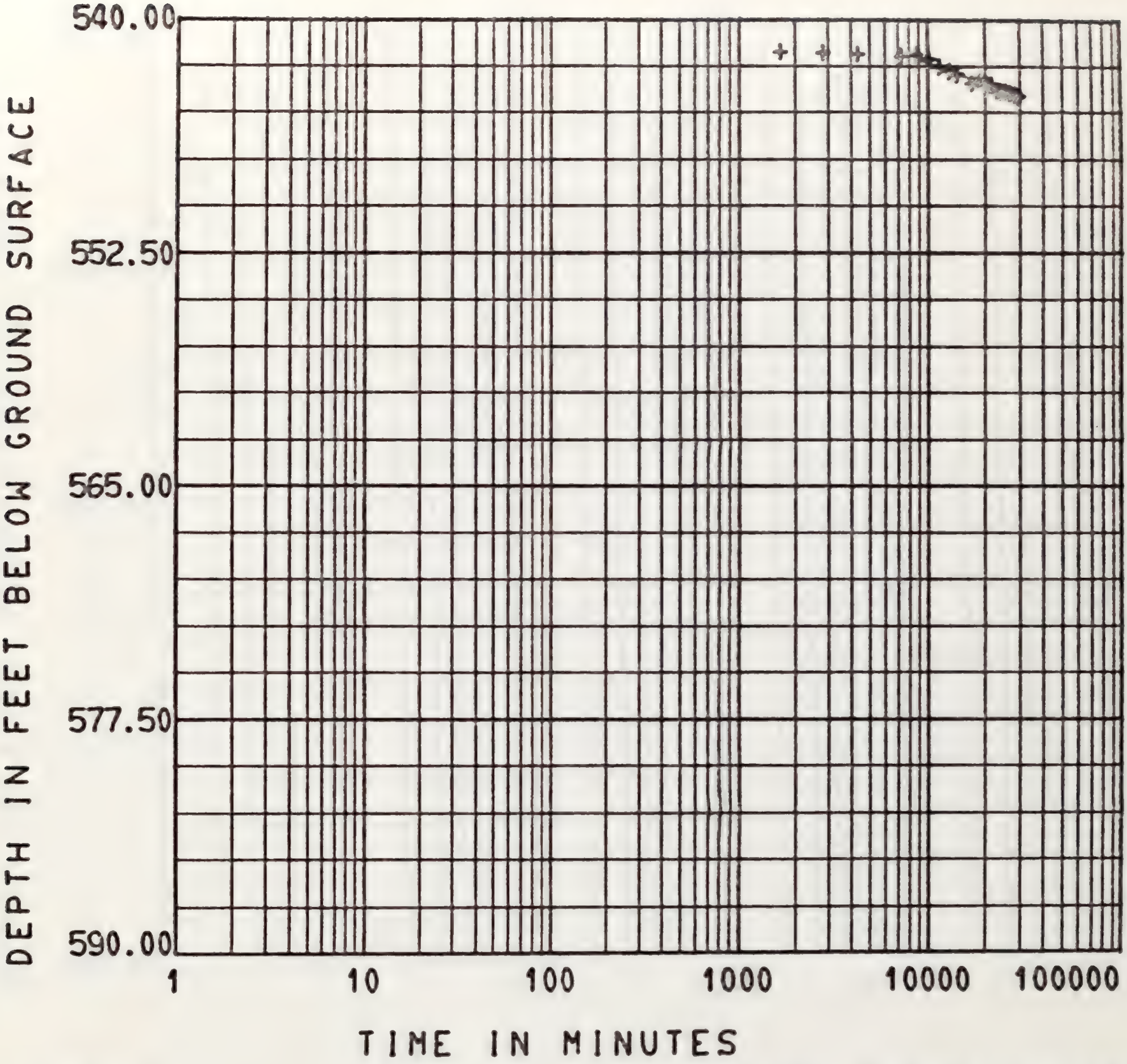
GSM-1 GS-19 LOWR RECOVERY



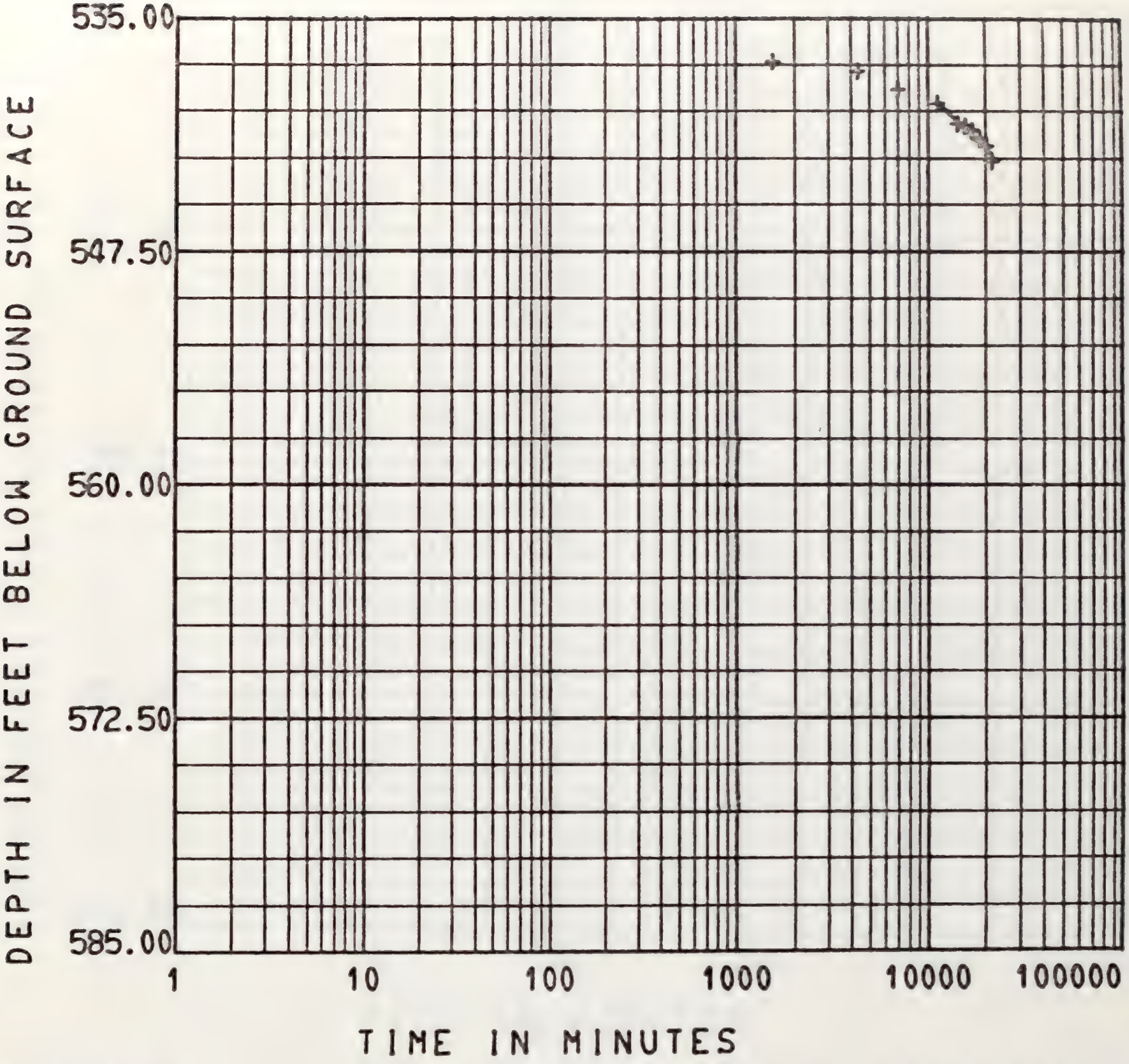
GSM-2 CE 705A UPPR DRAWDOWN



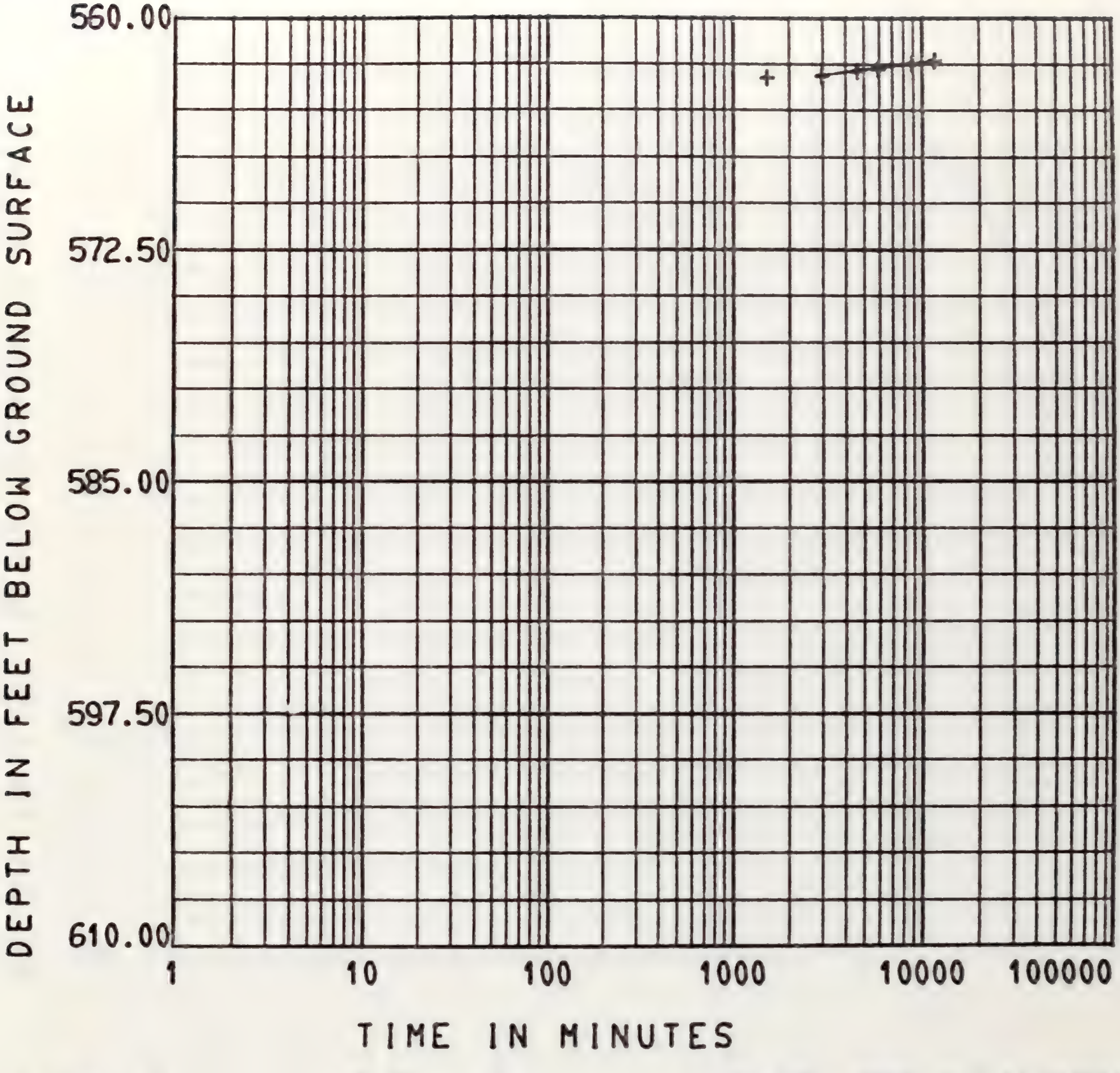
GSM-2 CE 705A UPPR RECOVERY



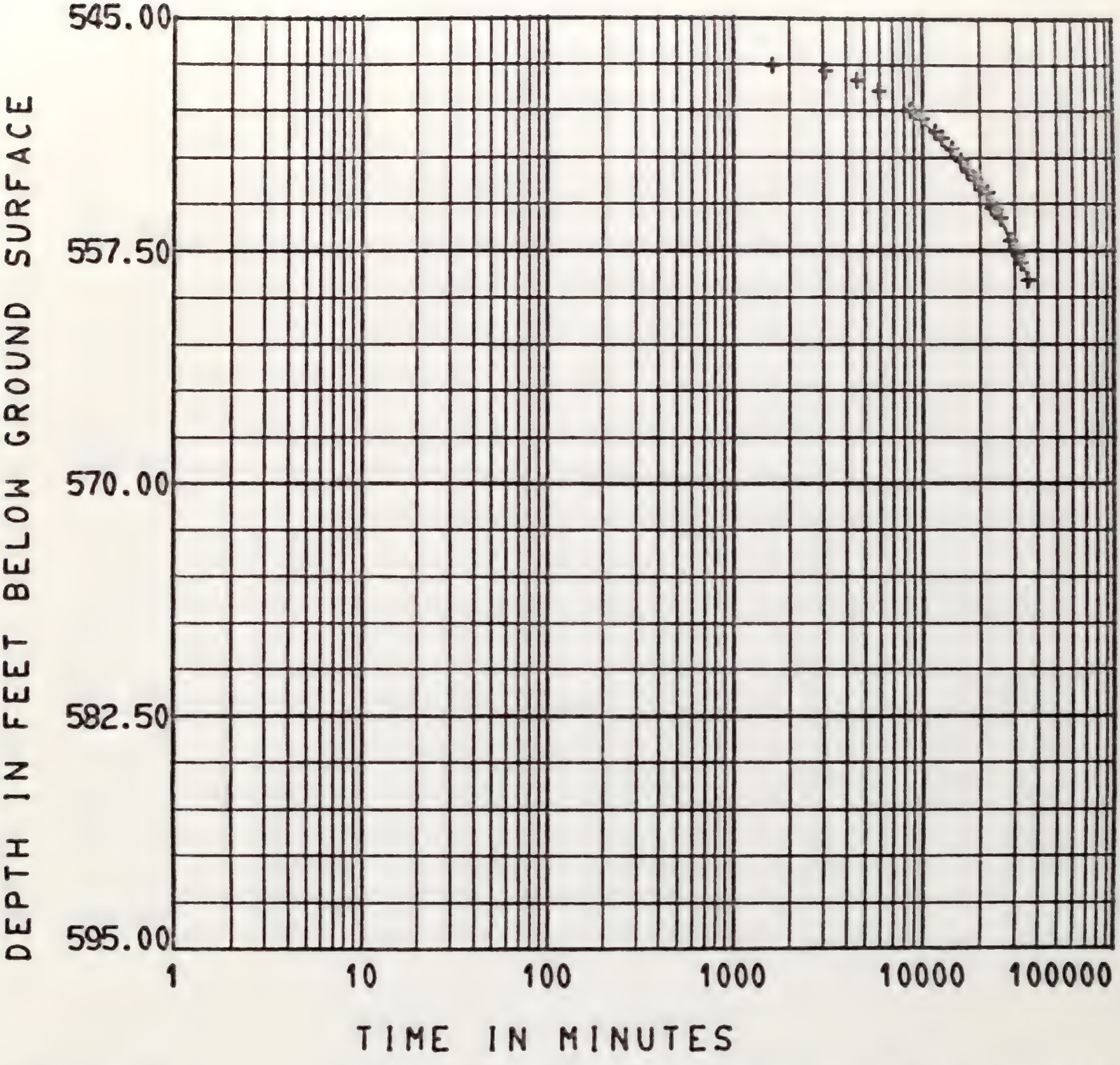
GSM-4 GS-16 LOWR DRAWDOWN



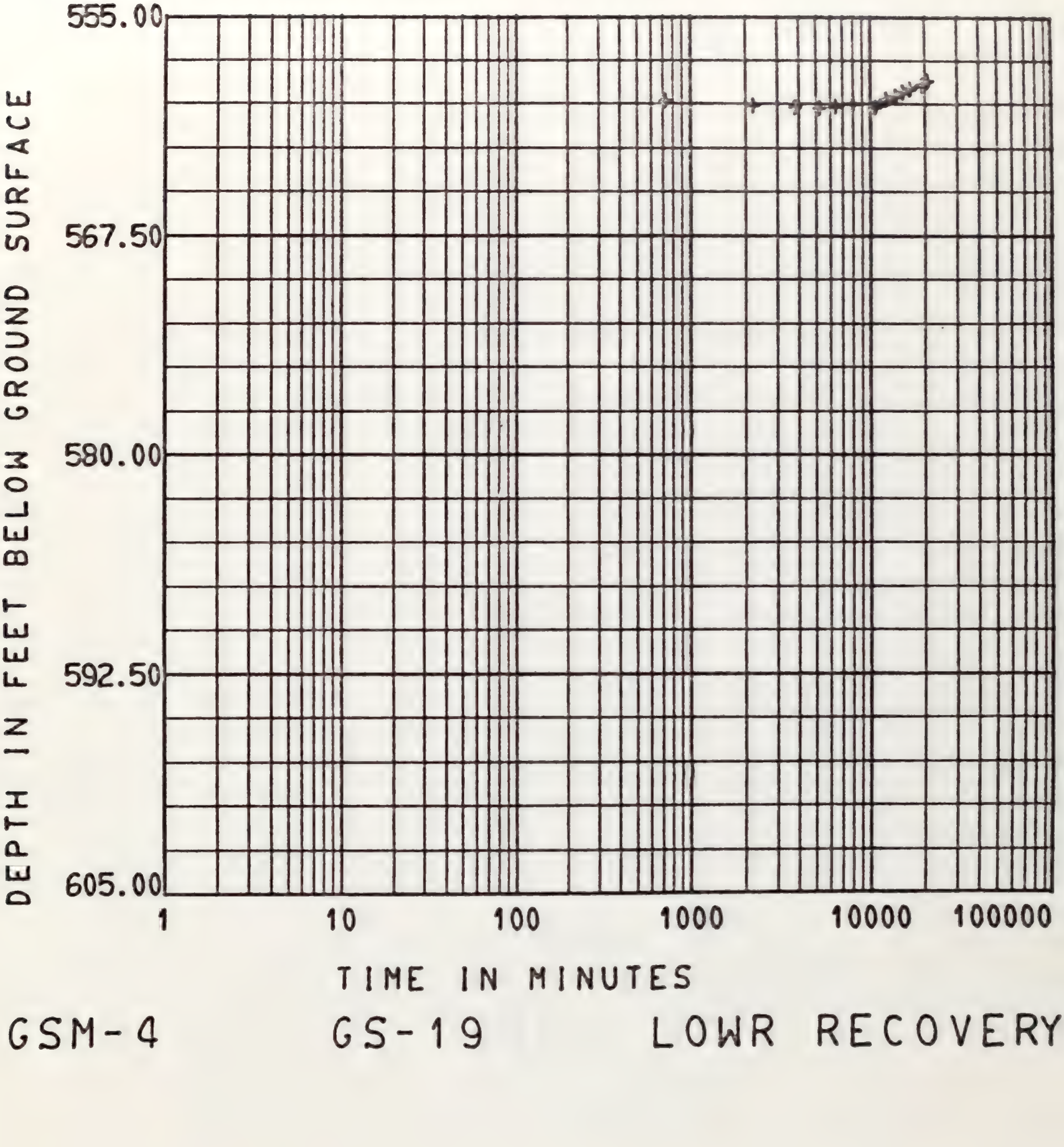
GSM-4 GS-17 LOWR DRAWDOWN



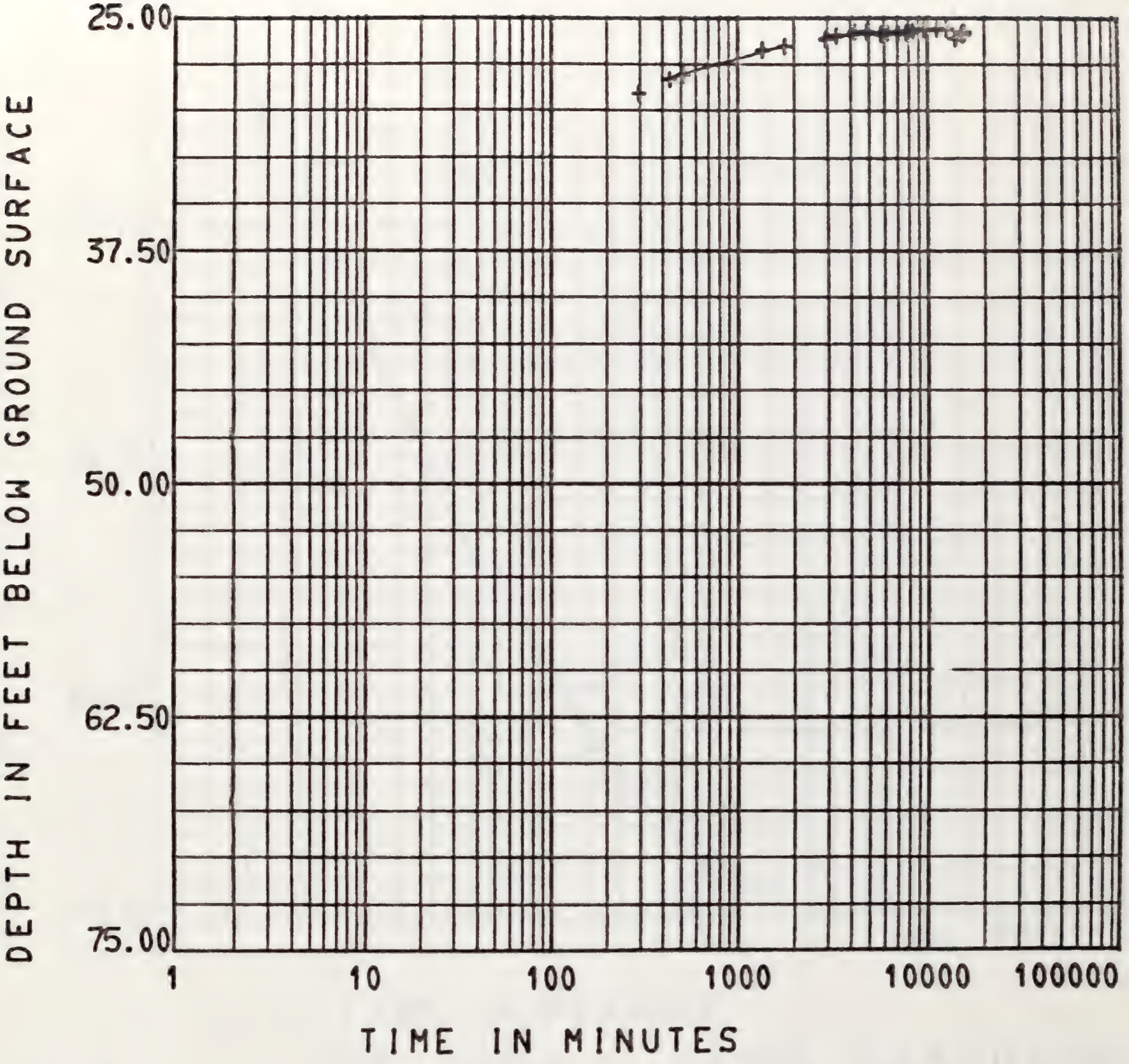
GSM-4 GS-18 LOWR RECOVERY



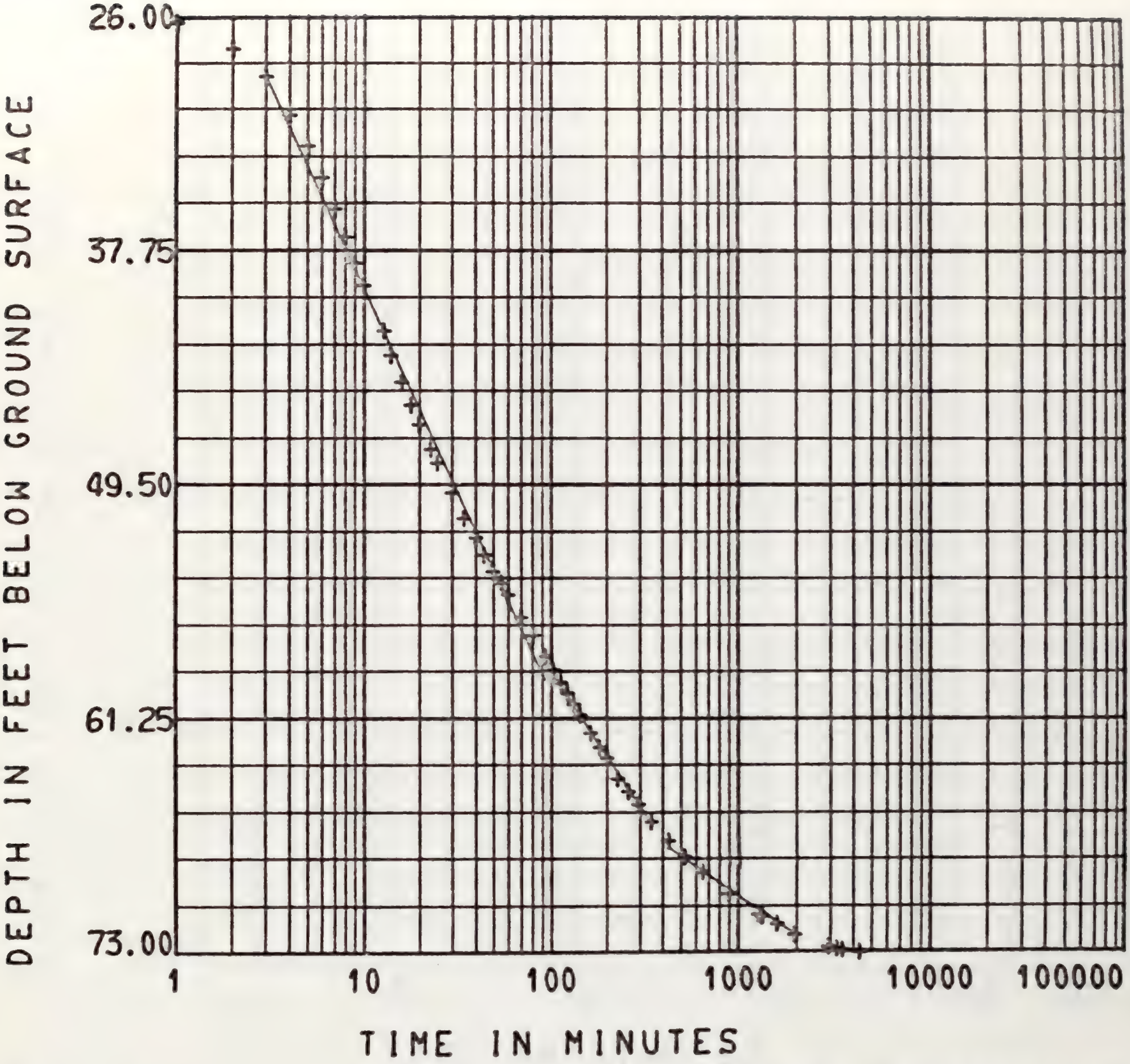
GSM-4 GS-19 LOWR DRAWDOWN



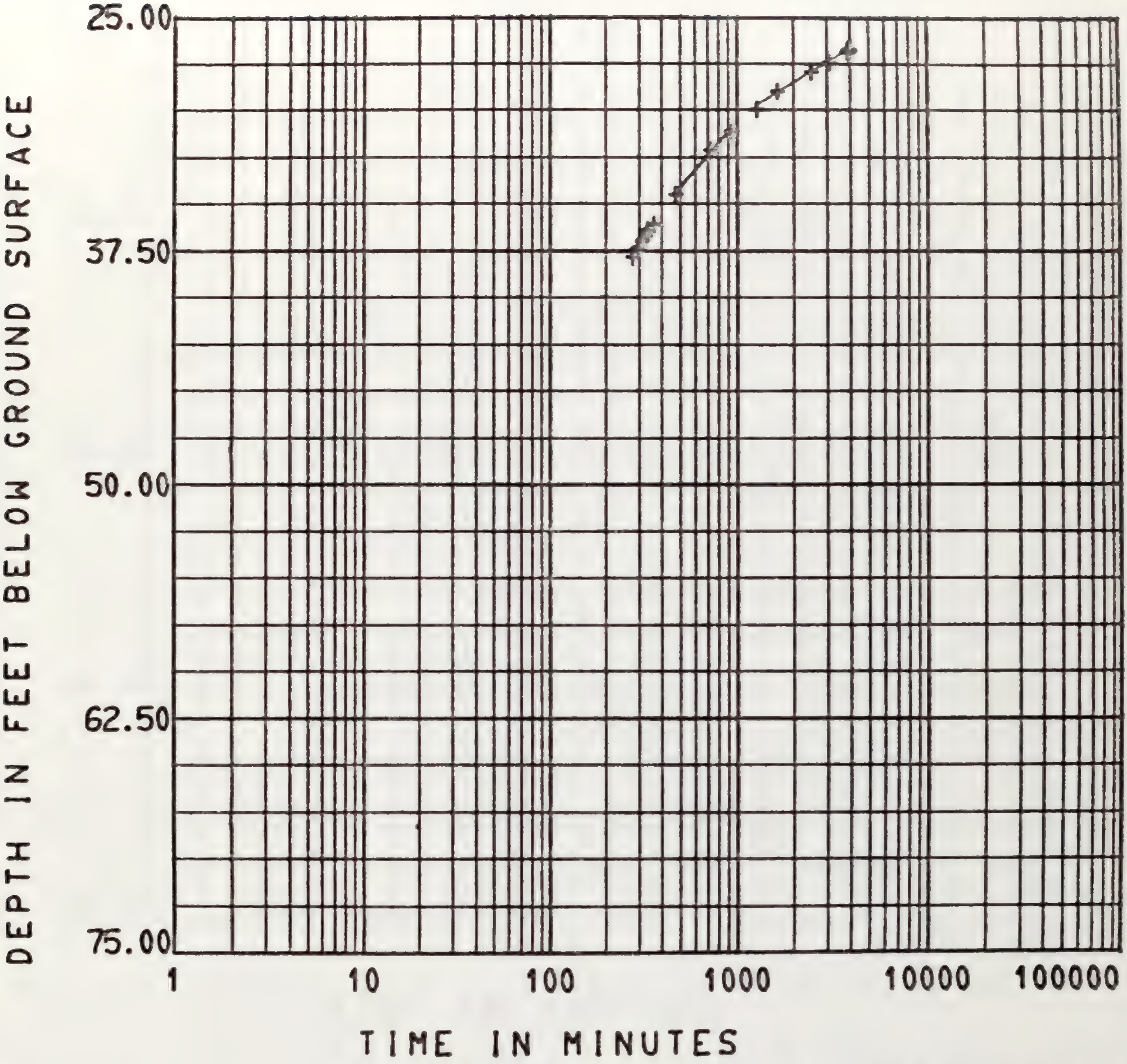
GSM-4 GS-19 LOWR RECOVERY



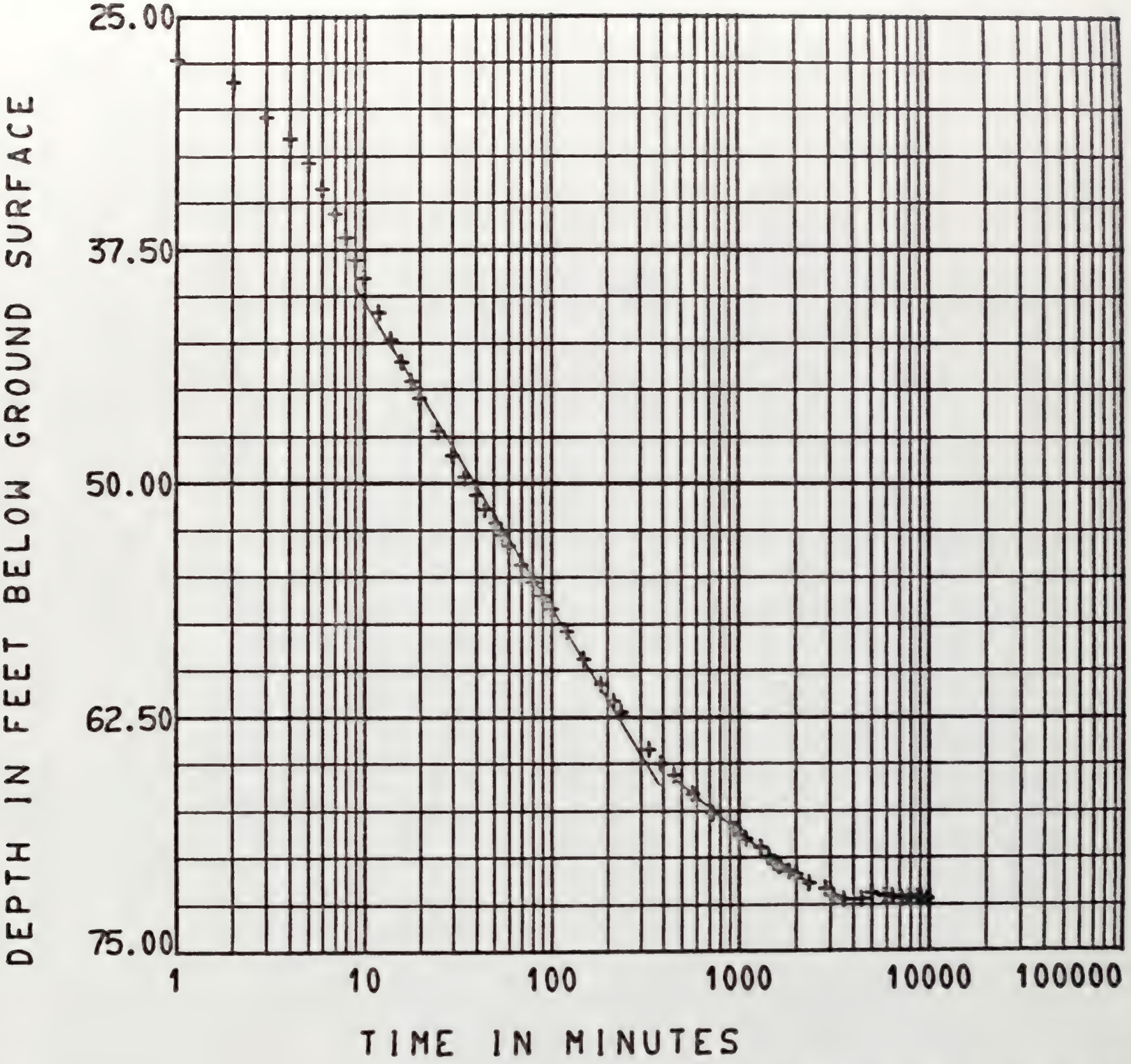
TO-1 CE 705A UPPR RECOVERY



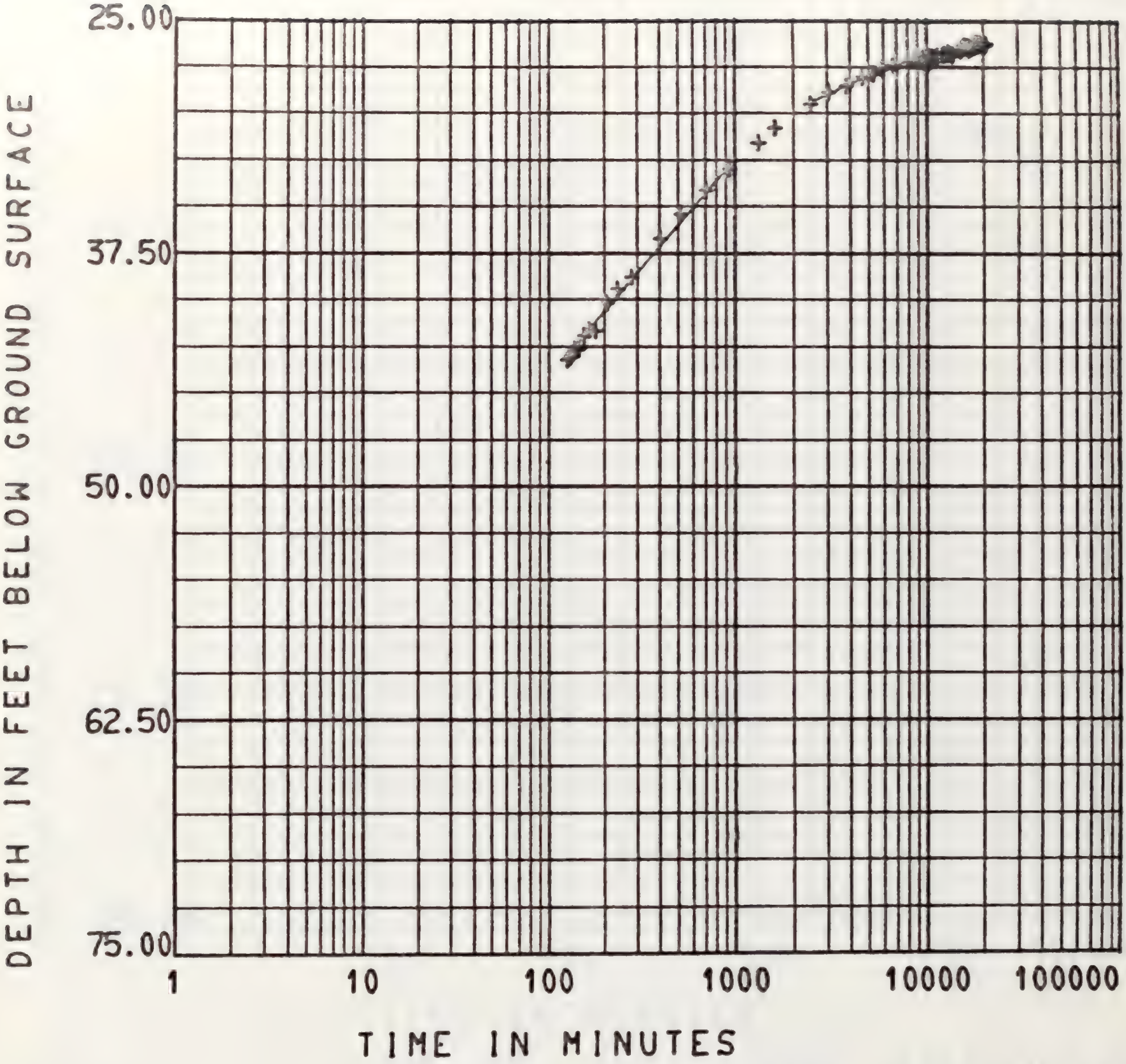
TO-1 CE 705A UPPR DRAWDOWN



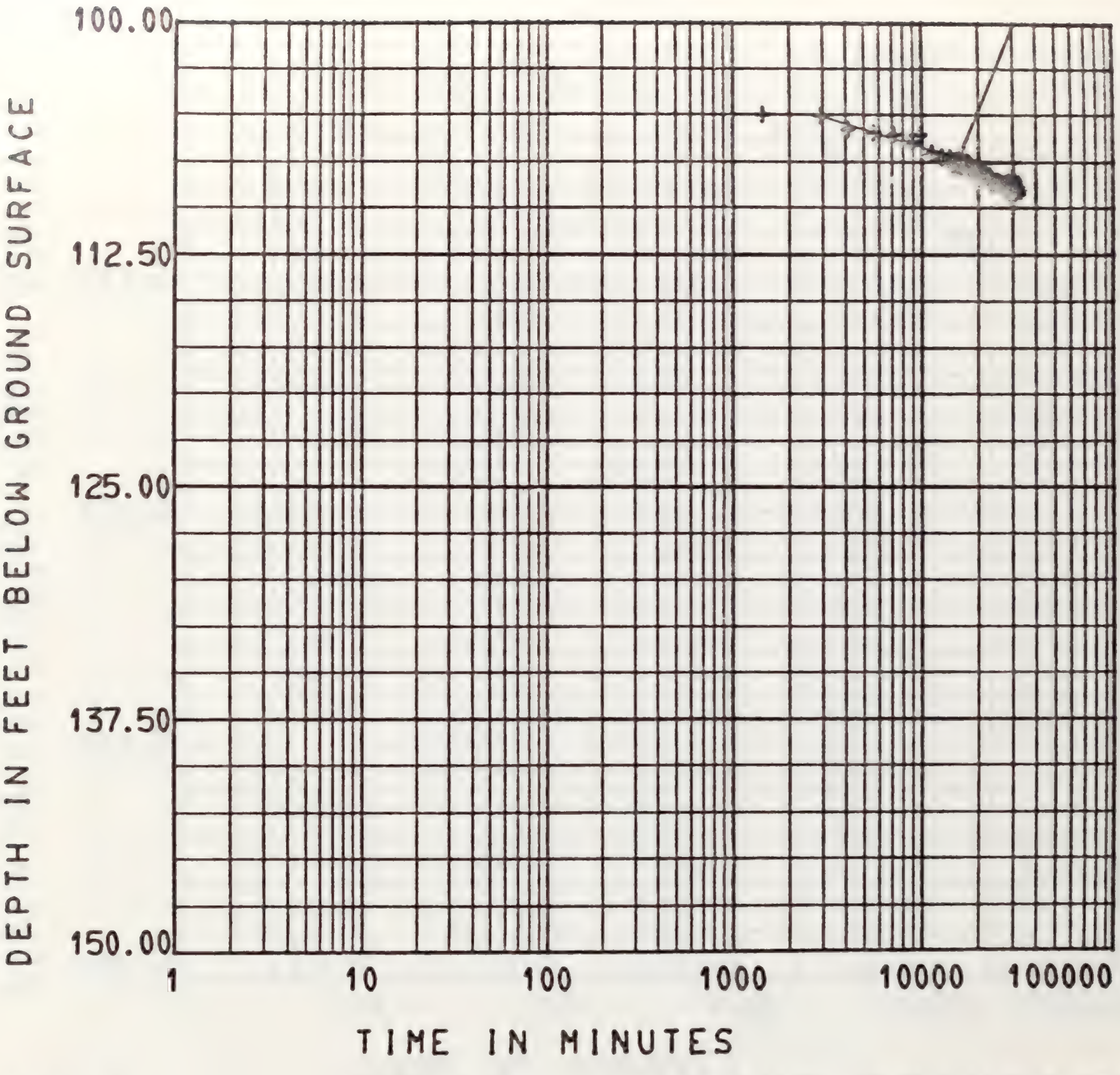
TO-1 CE 705A UPPR RECOVERY



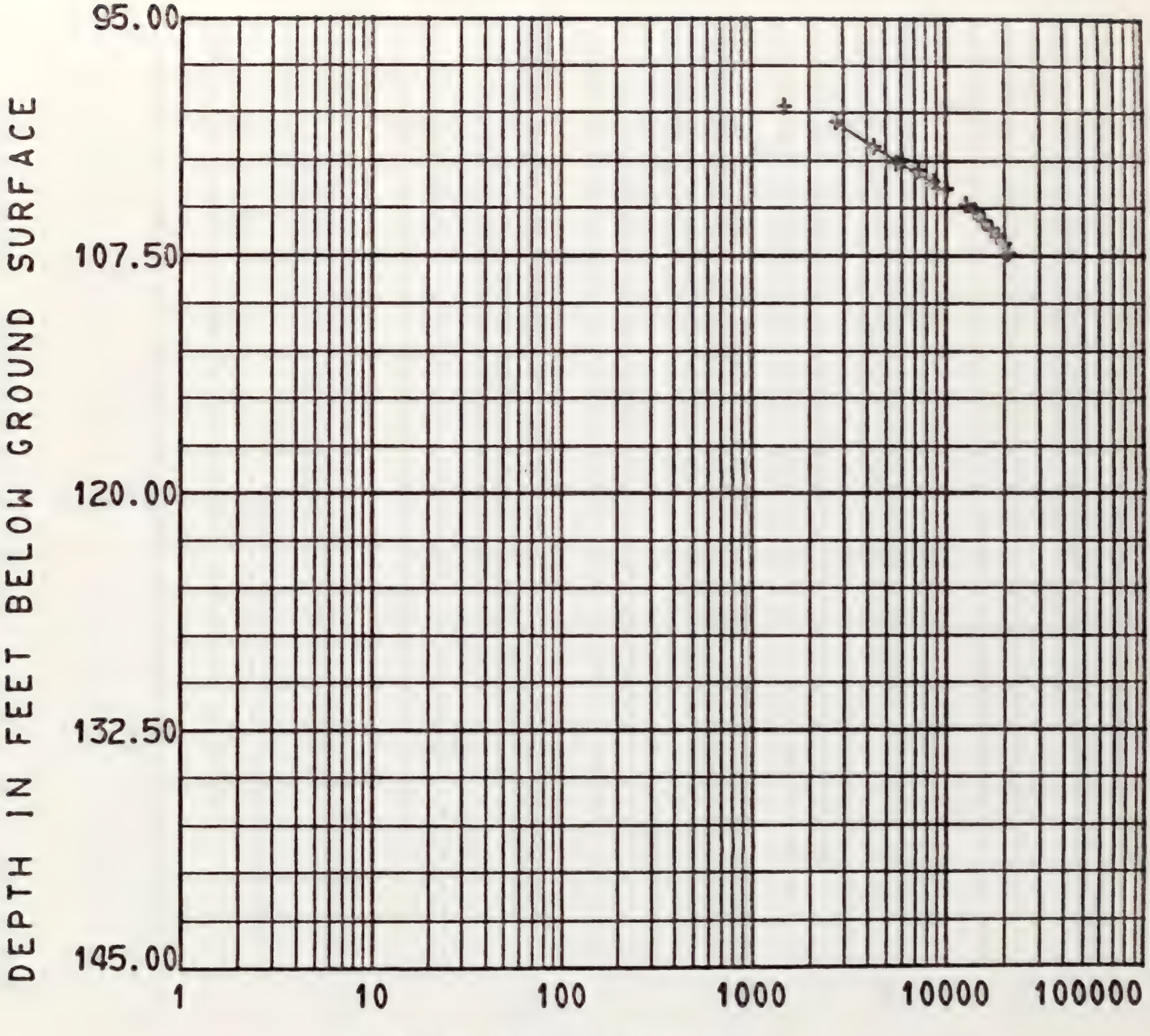
TO-1 CE 705A UPPR DRAWDOWN



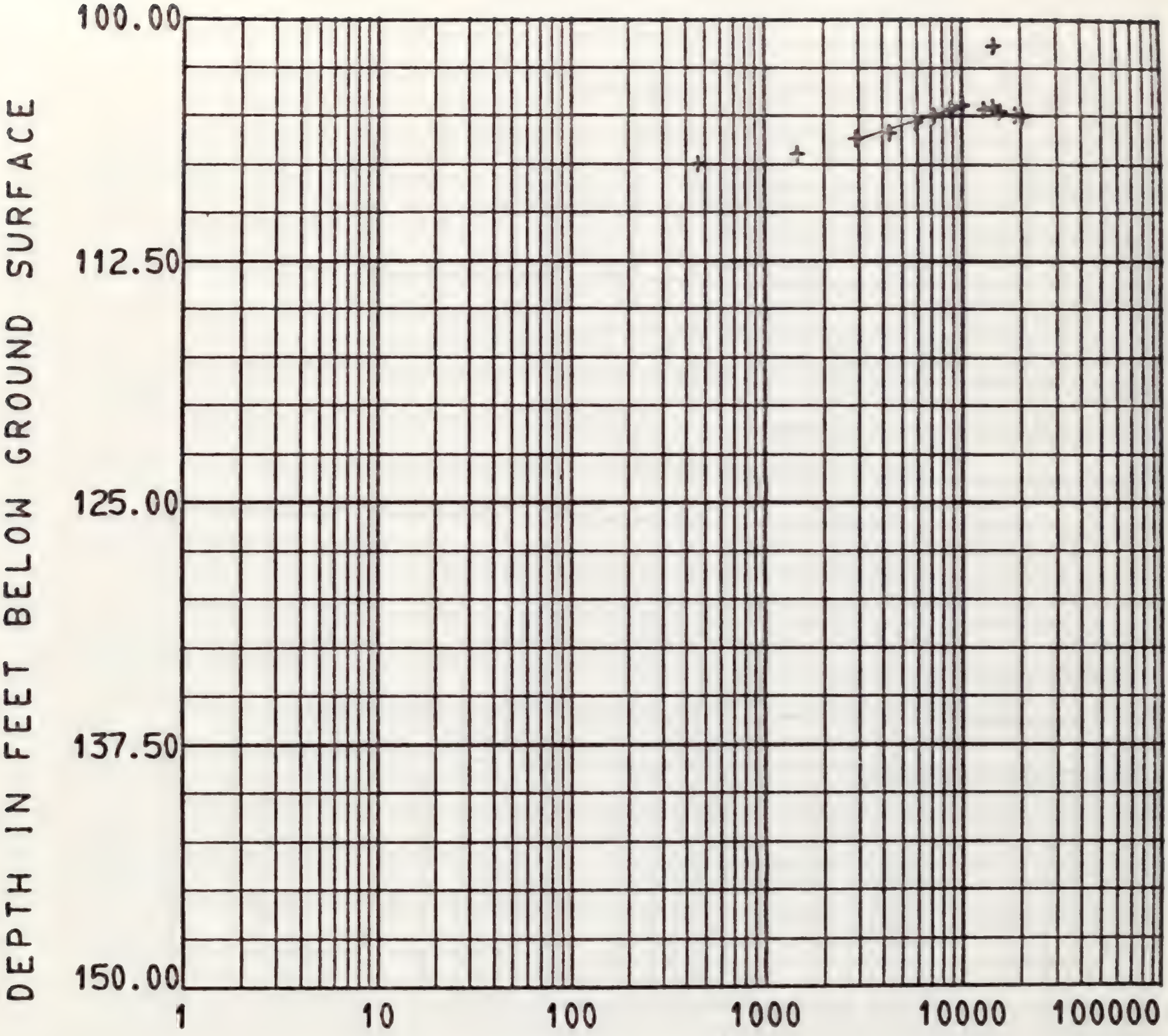
TO-1 CE 705A UPPR RECOVERY



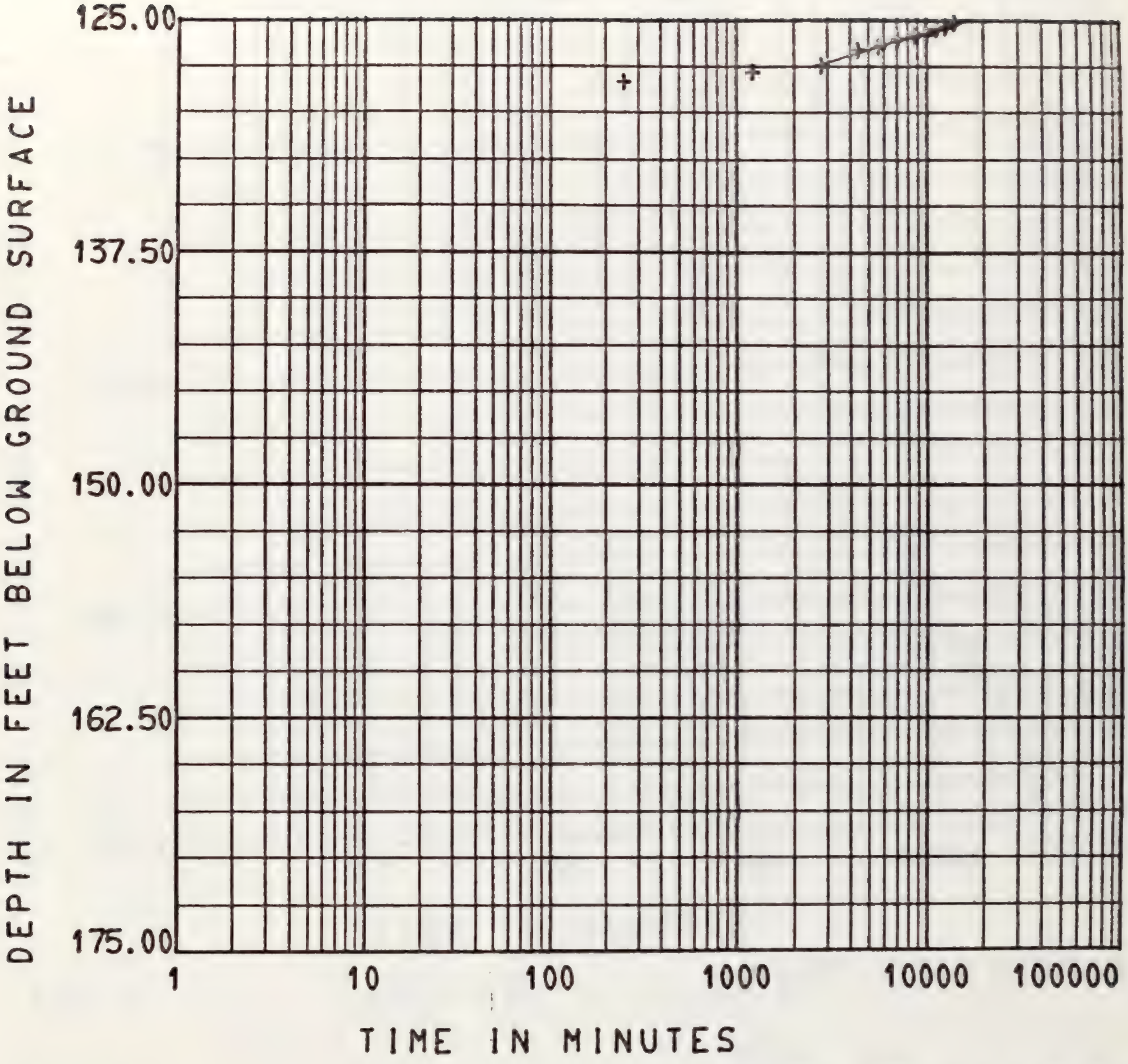
TO-1 GS-16 LOWR DRAWDOWN



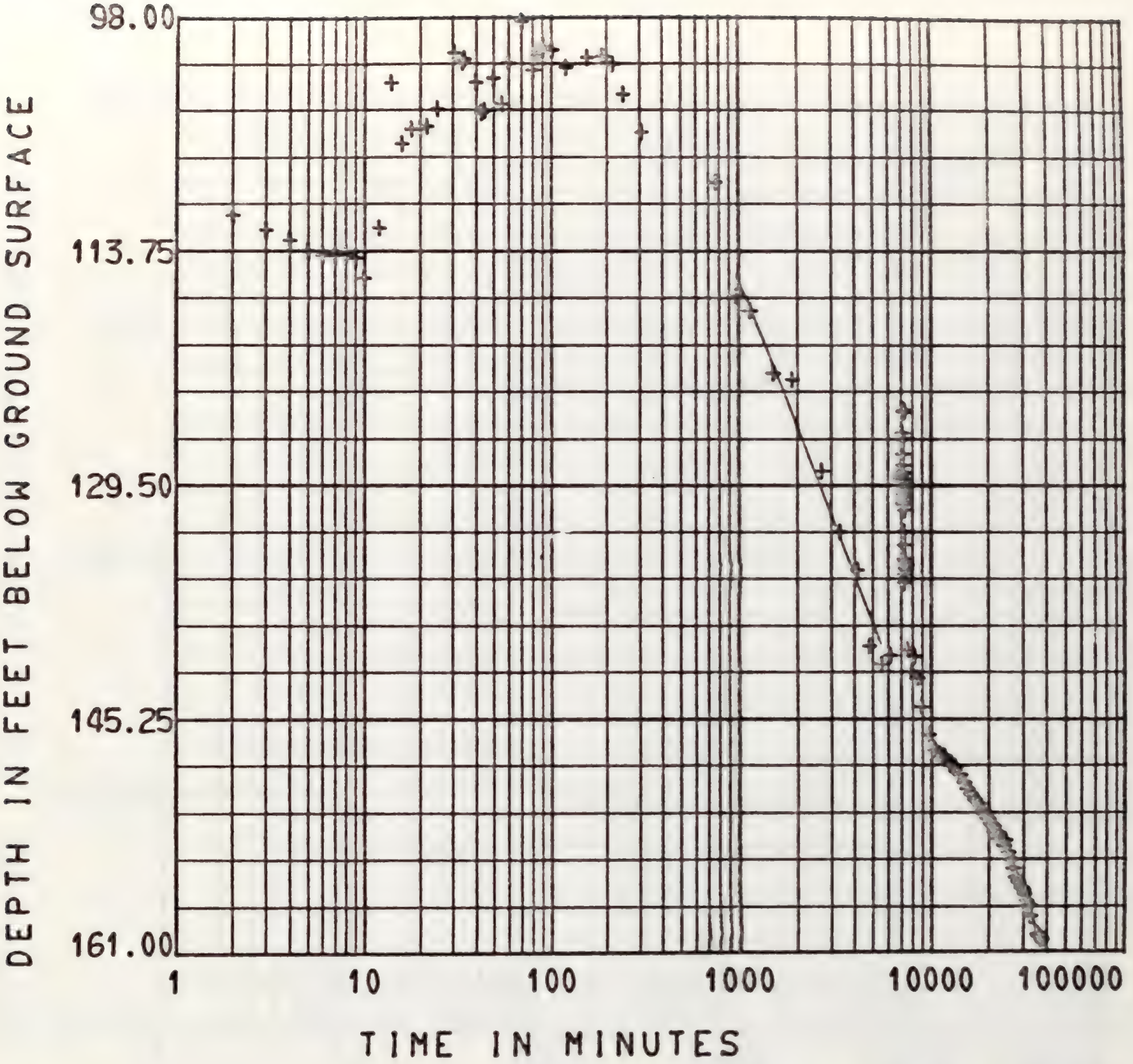
TO-1 GS-17 LOWR DRAWDOWN



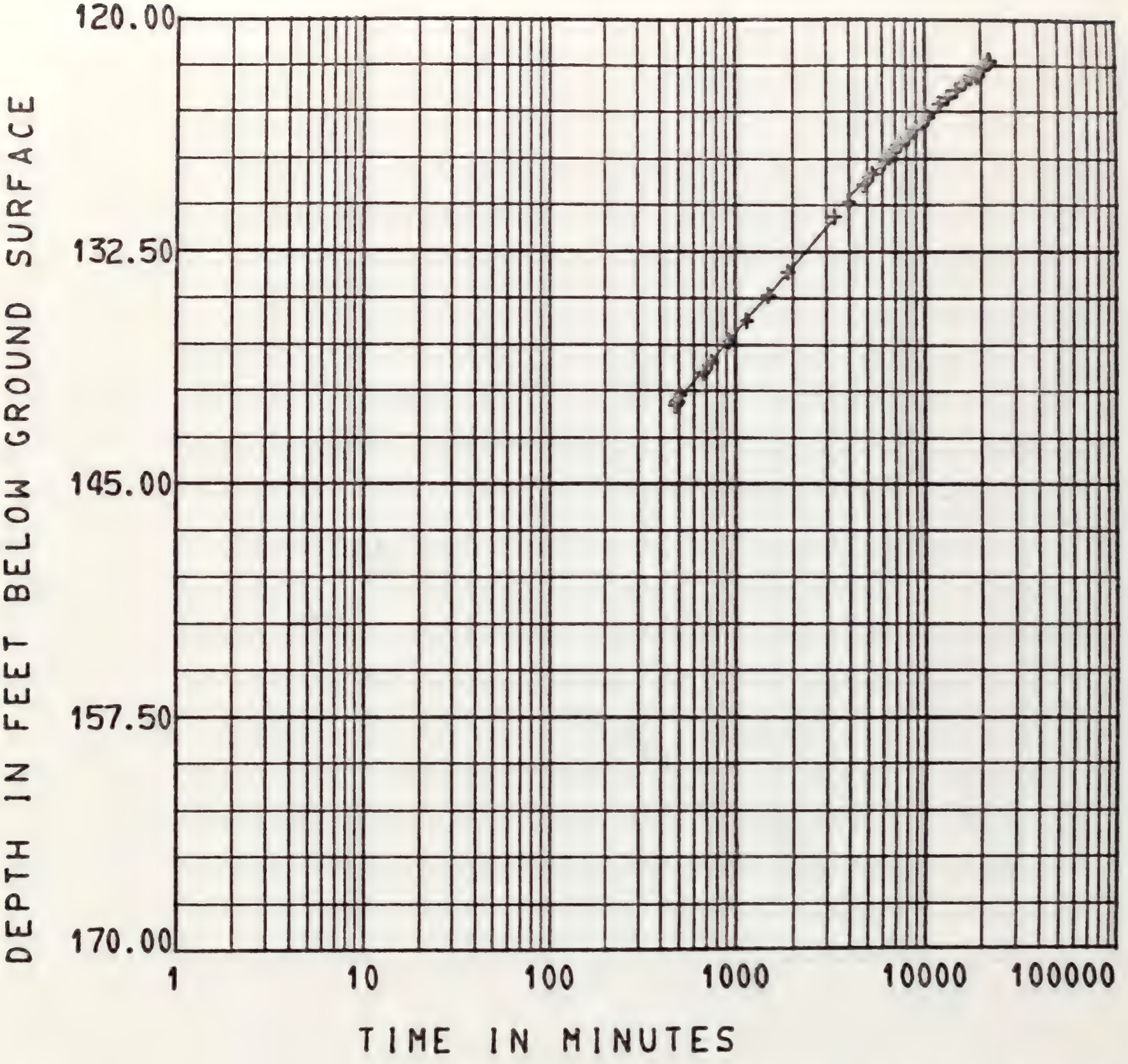
TO-1 GS-17 LOWR RECOVERY



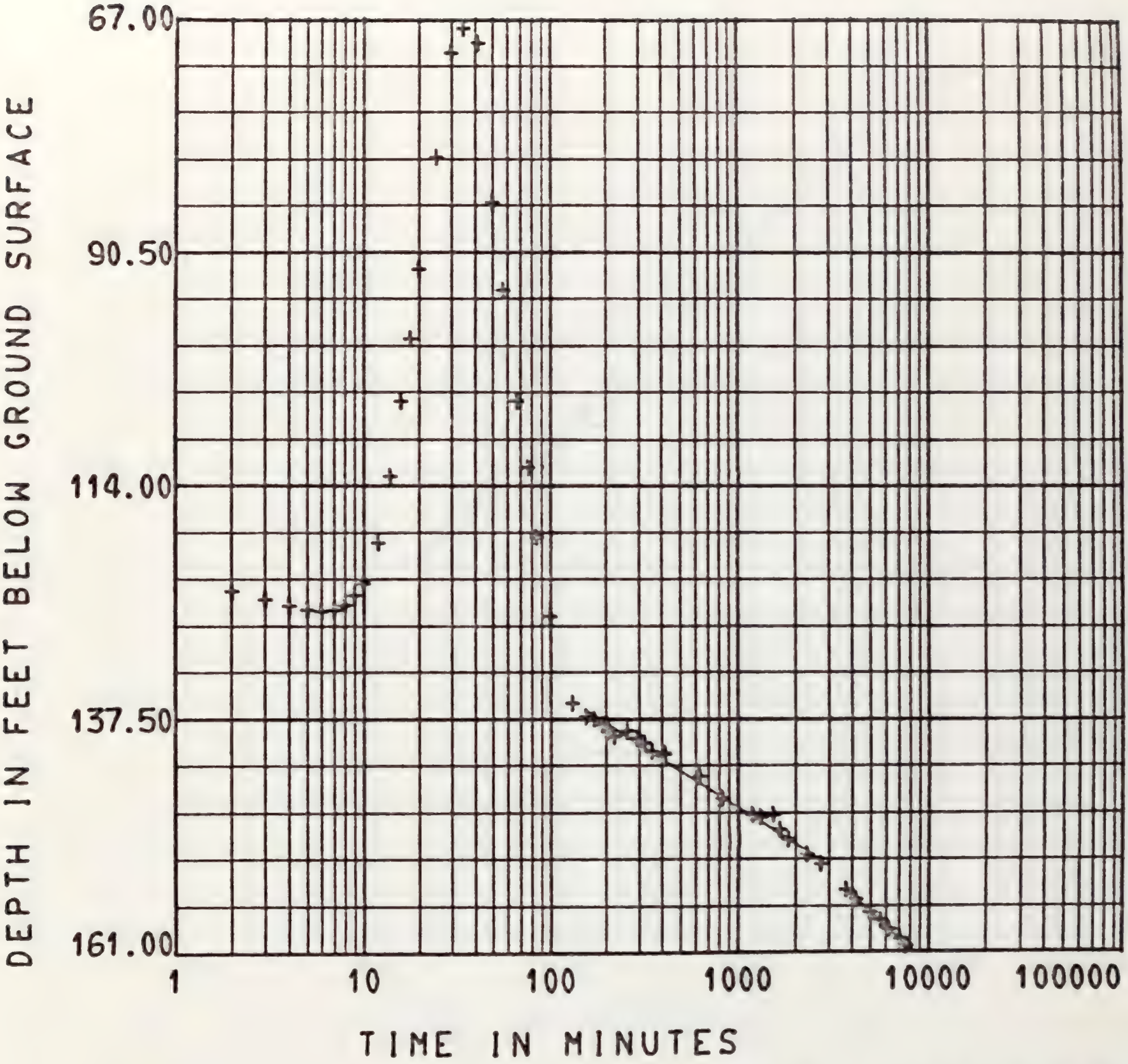
TO-1 GS-18 LOWR RECOVERY



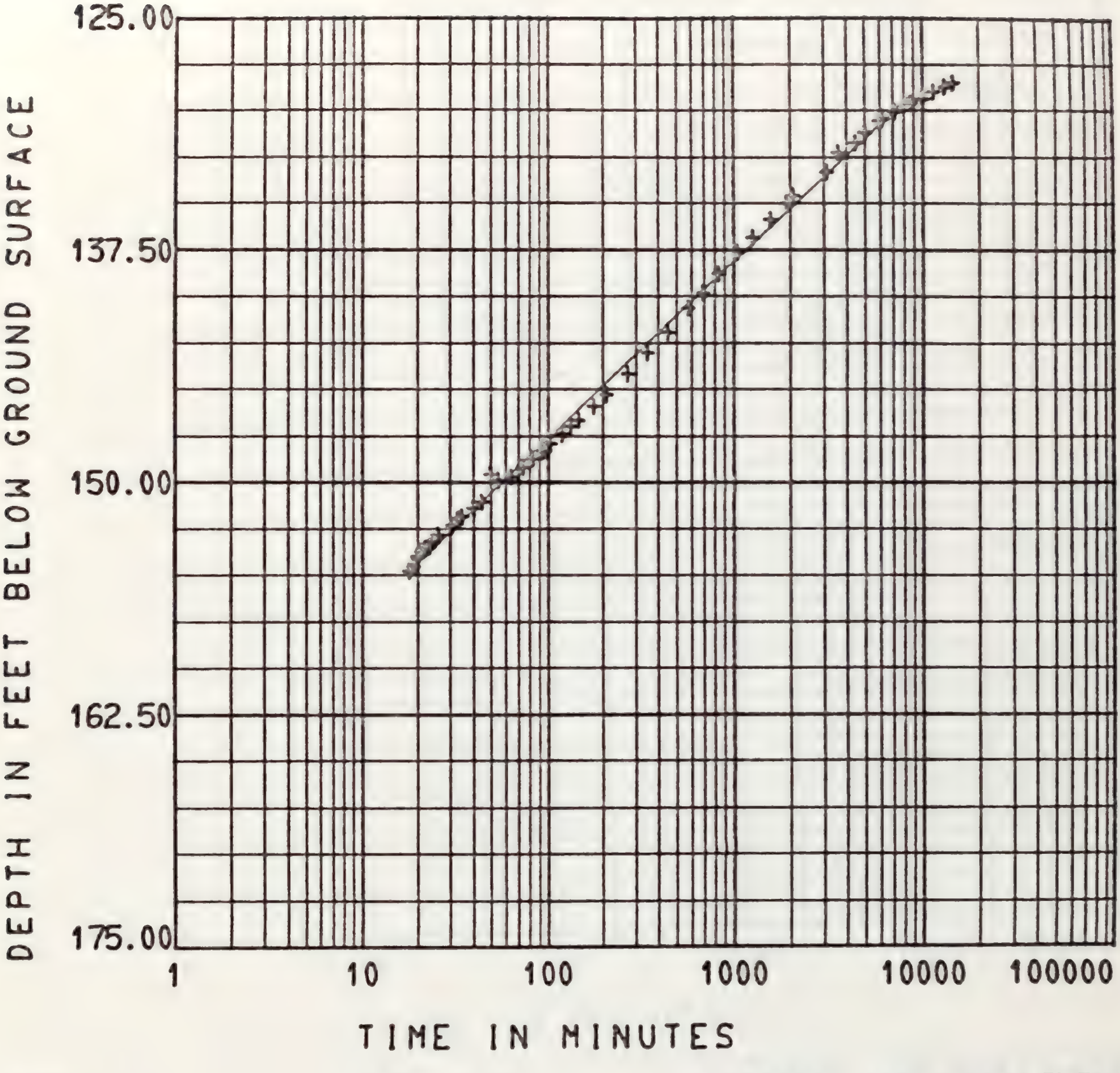
TO-1 GS-19 LOWR DRAWDOWN



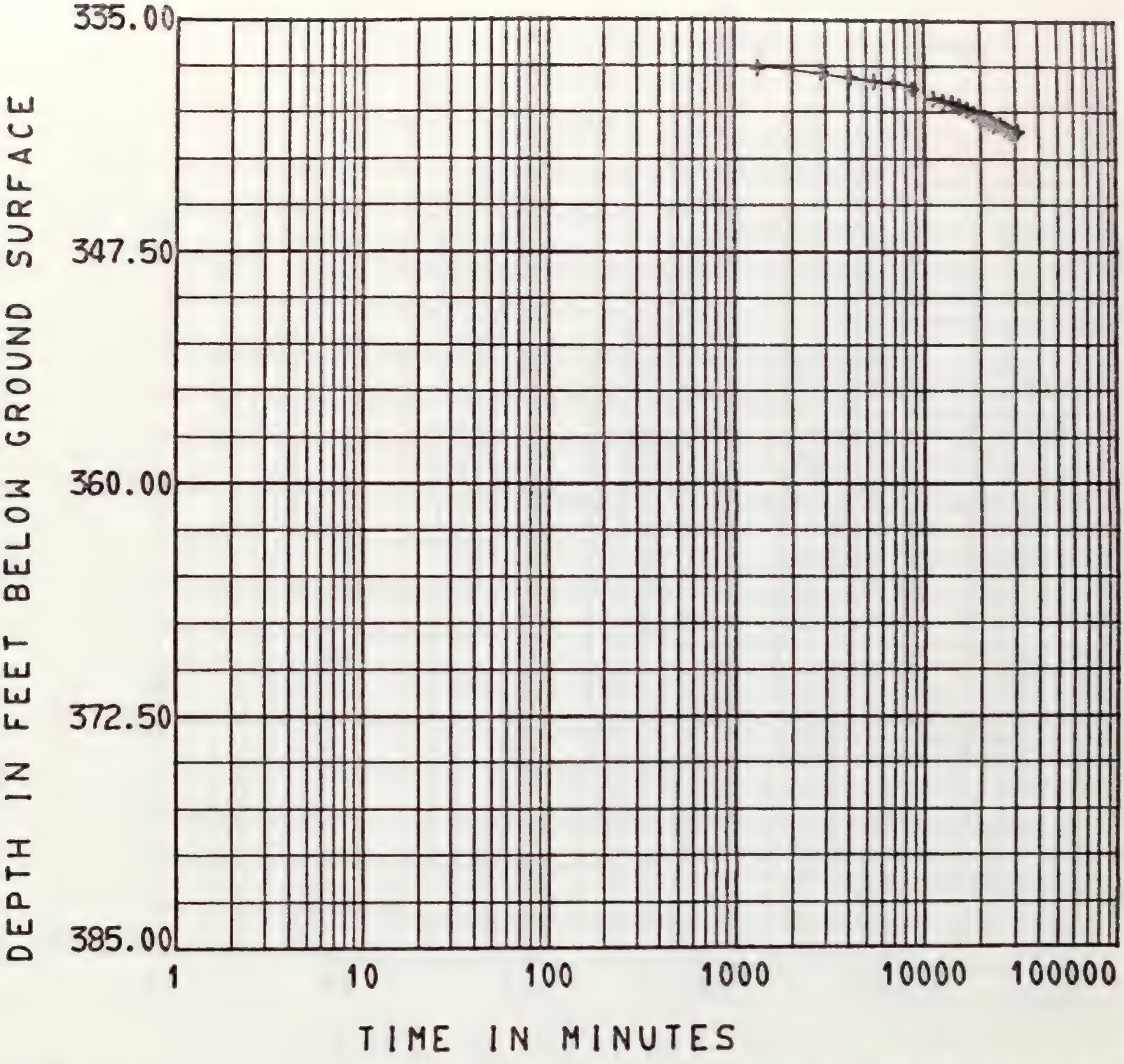
TO-1 GS-19 LOWR RECOVERY



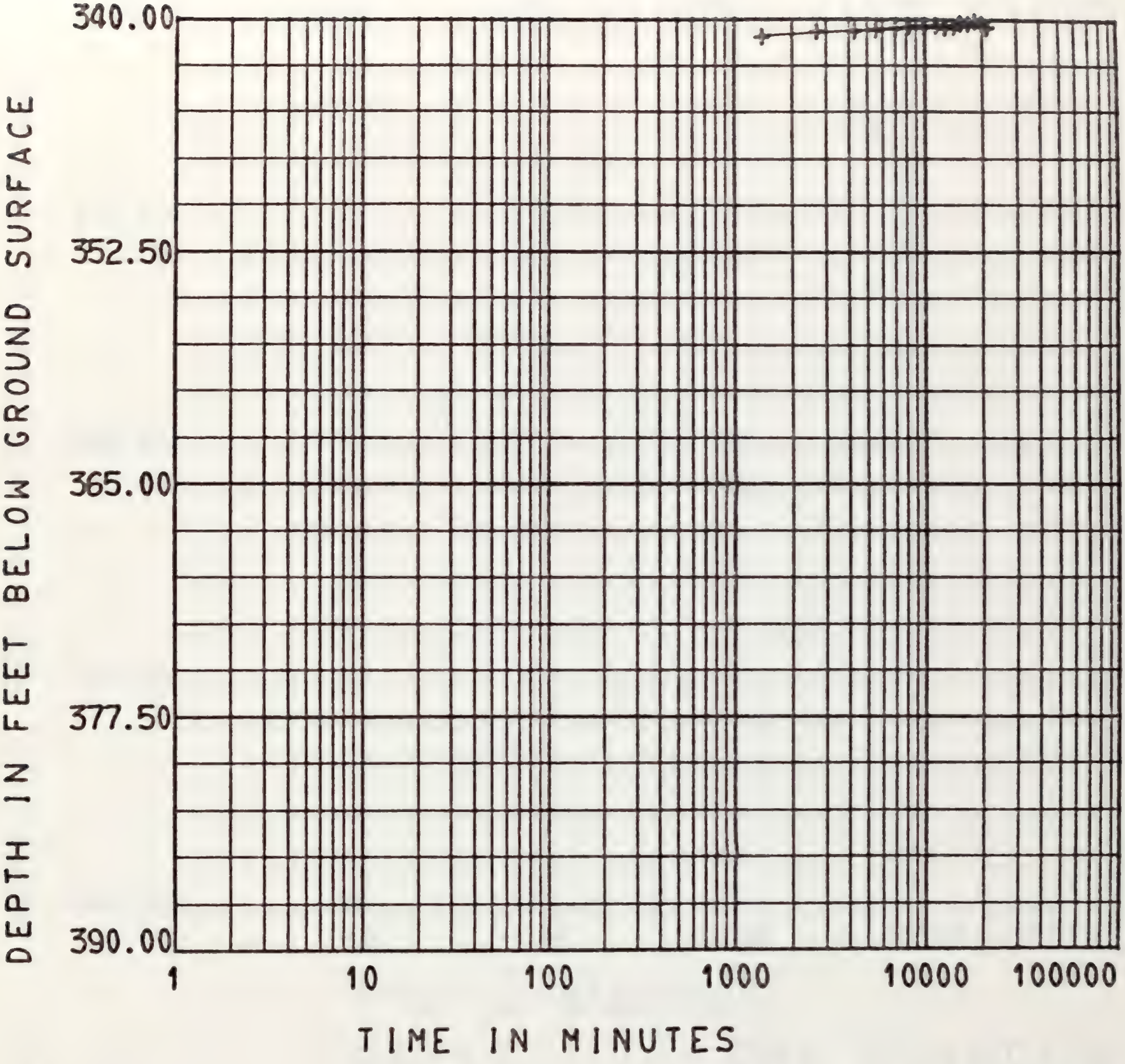
TO-1 GS-19 LOWR DRAWDOWN



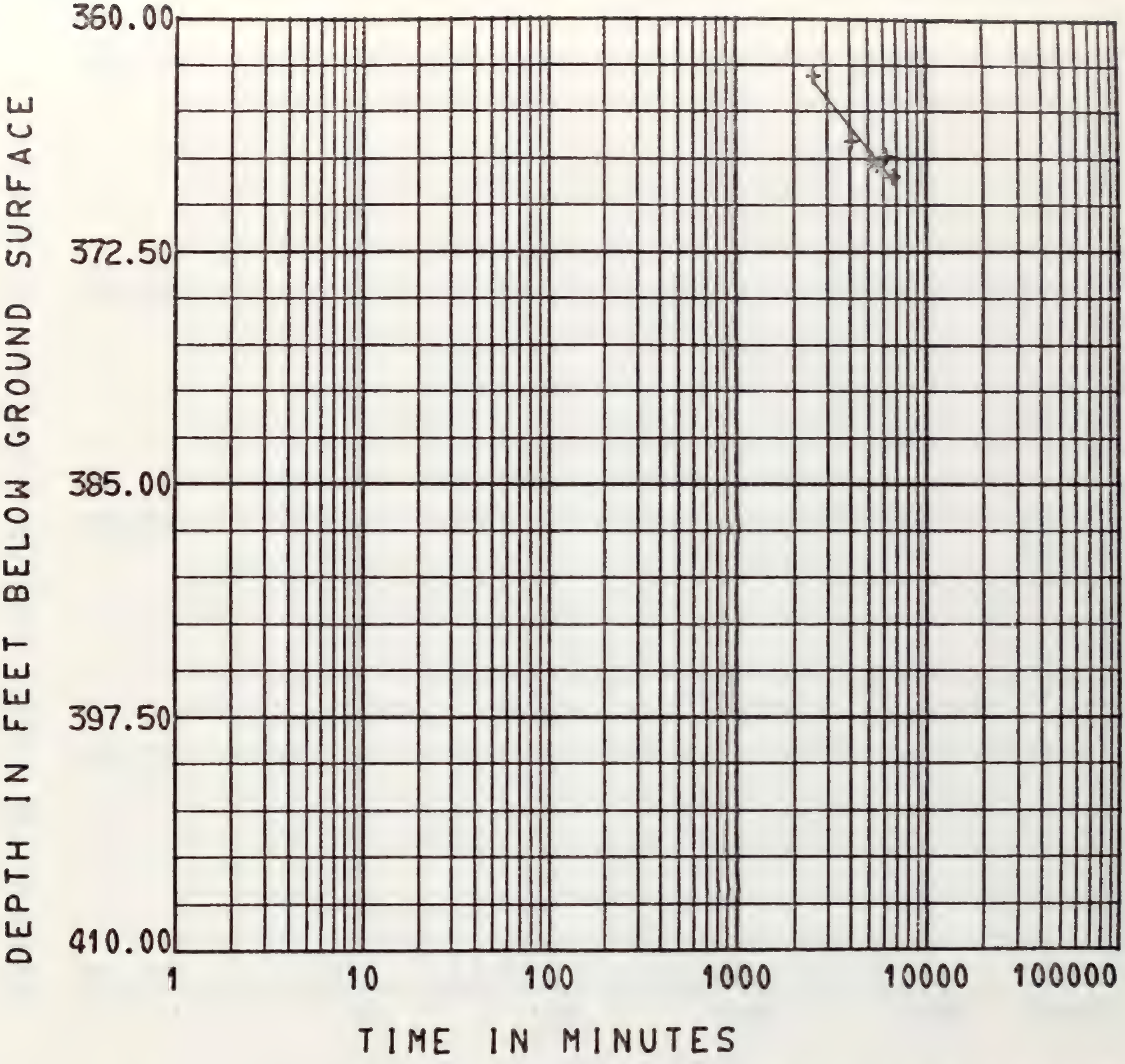
TO-1 GS-19 LOWR RECOVERY



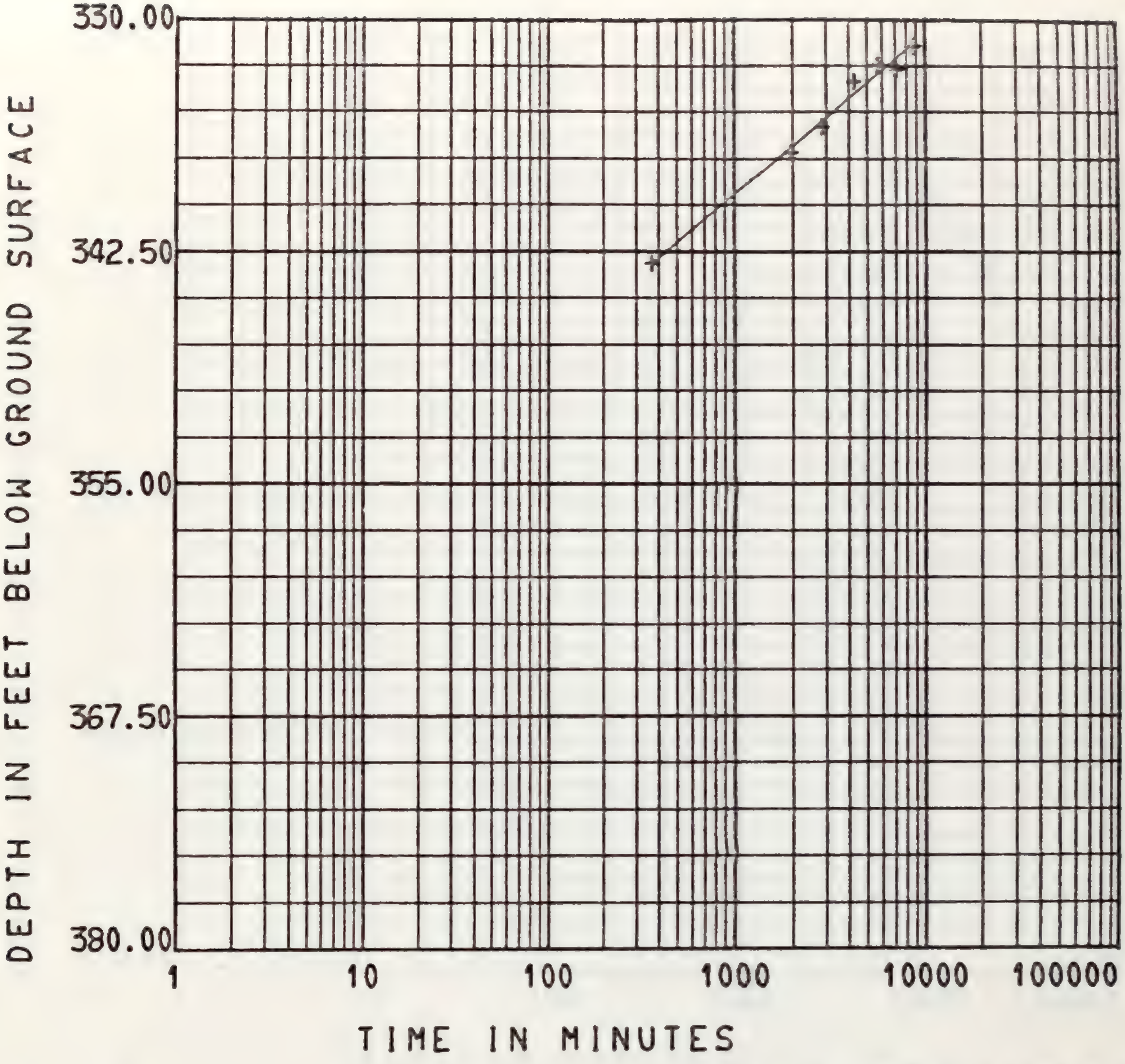
TO-2 GS-16 LOWR DRAWDOWN



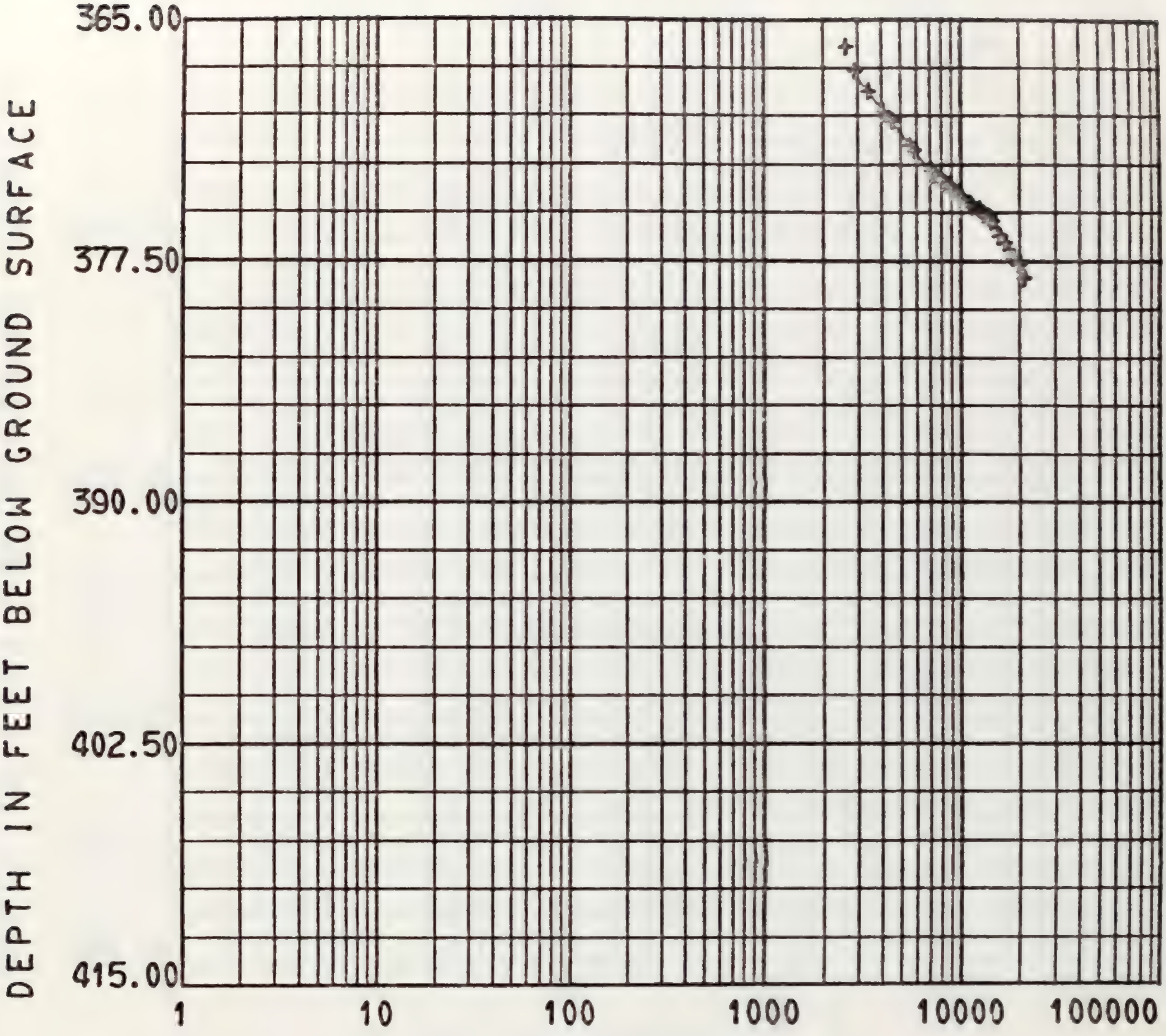
TO-2 GS-16 LOWR RECOVERY



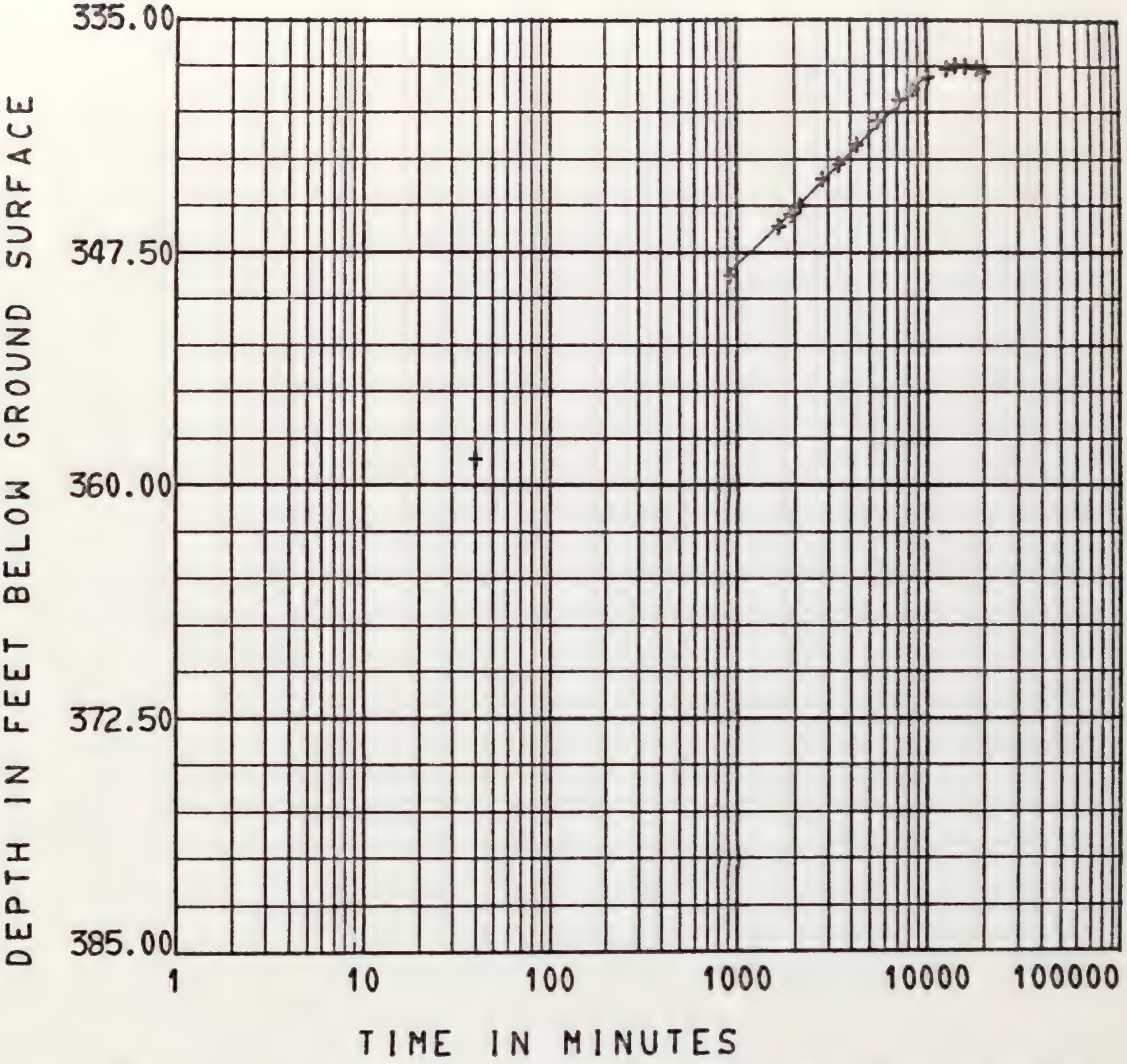
TO-2 GS-17 LOWR DRAWDOWN



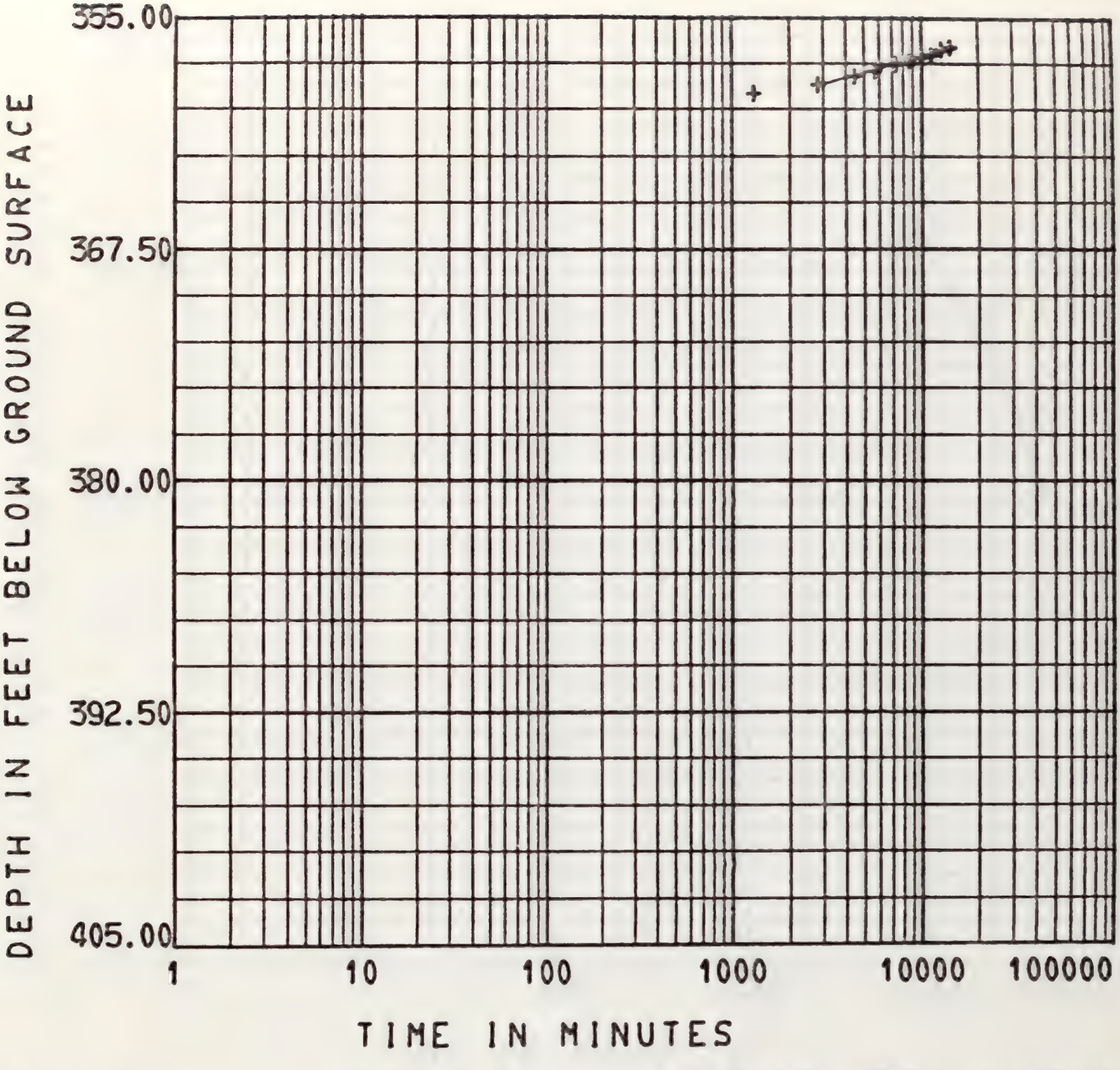
TO-2 GS-17 LOWR RECOVERY



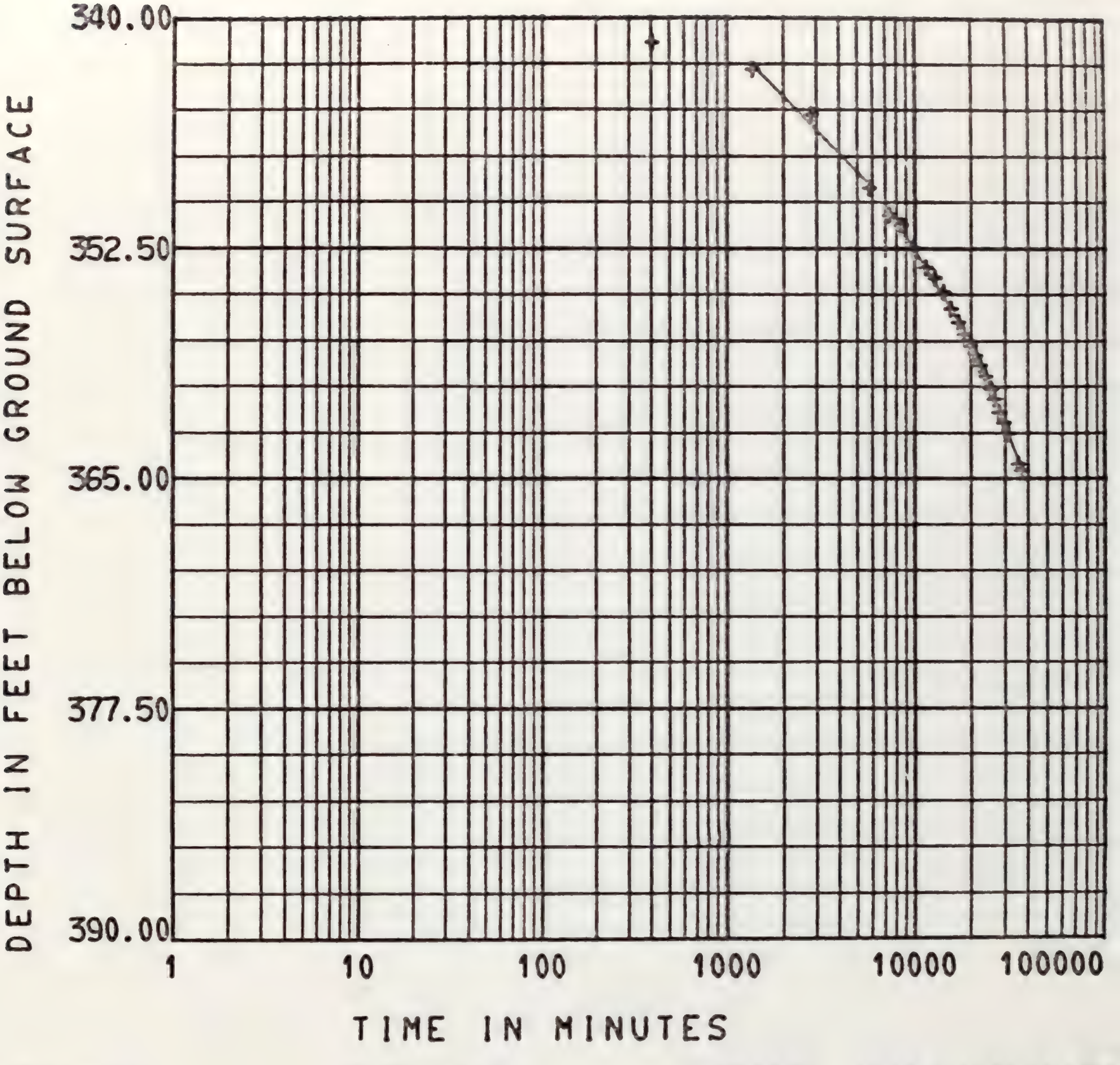
TO-2 GS-17 LOWR DRAWDOWN



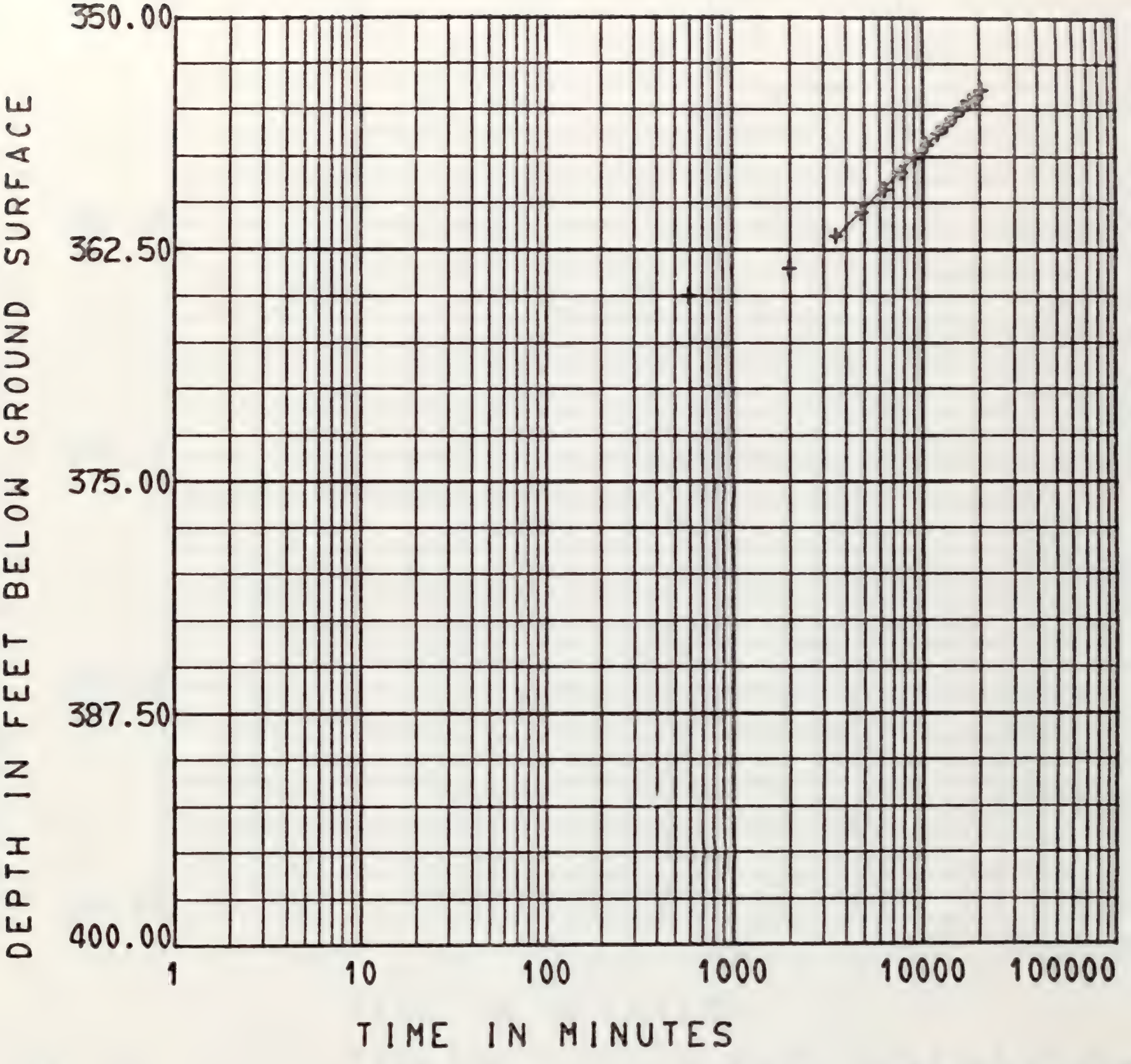
TO-2 GS-17 LOWR RECOVERY



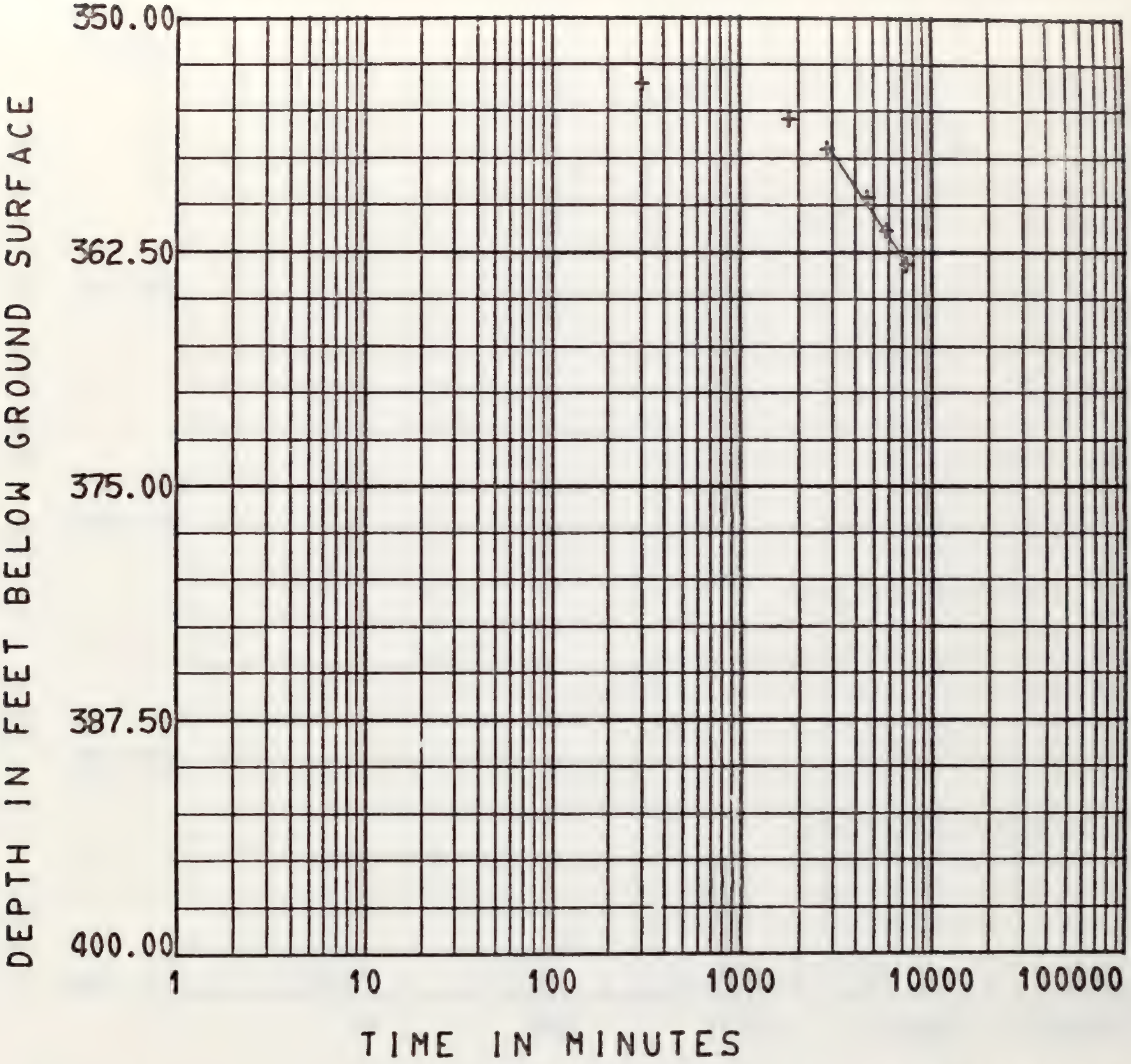
TO-2 GS-18 LOWR RECOVERY



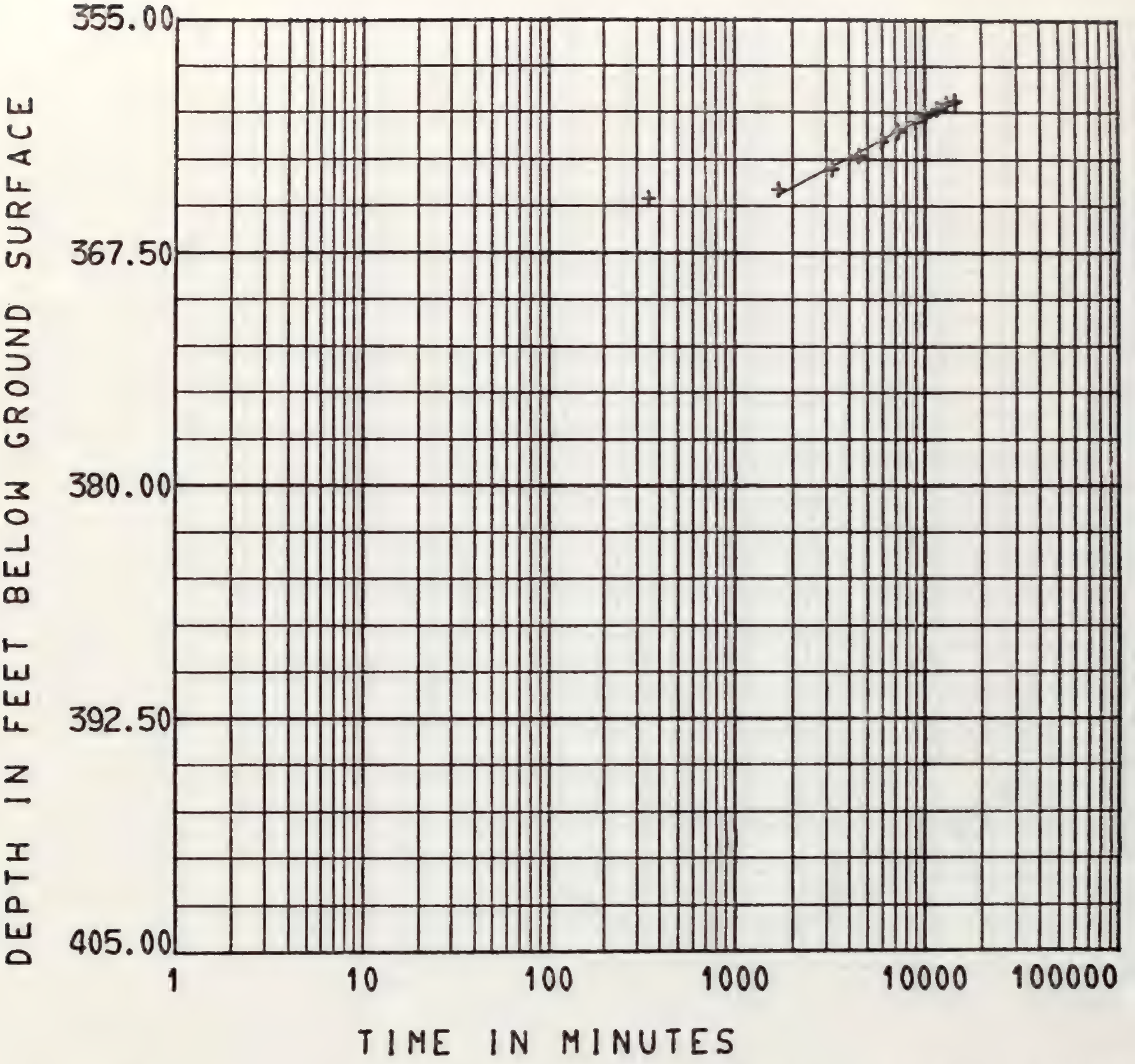
TO-2 GS-19 LOWR DRAWDOWN



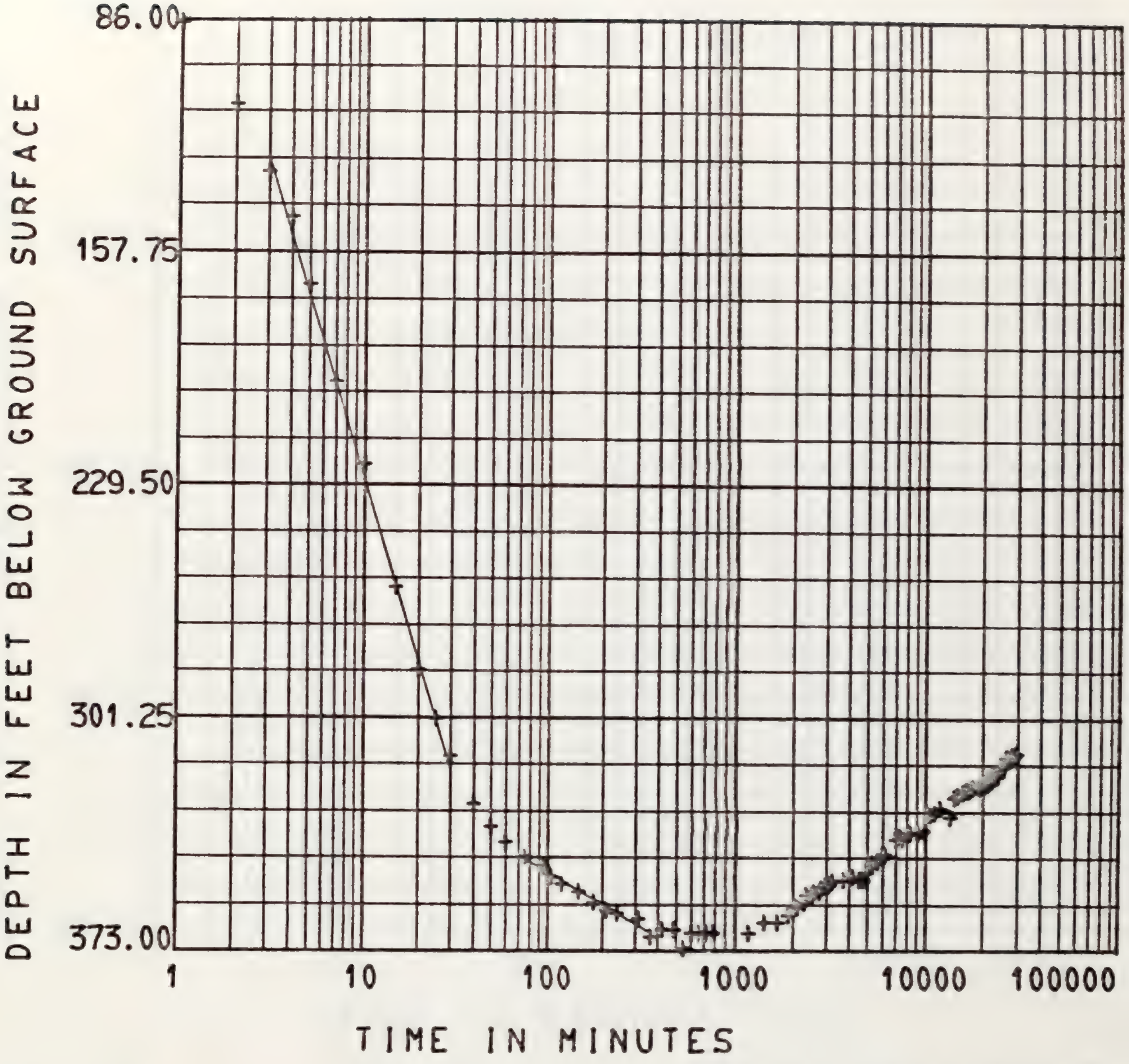
TO-2 GS-19 LOWR RECOVERY



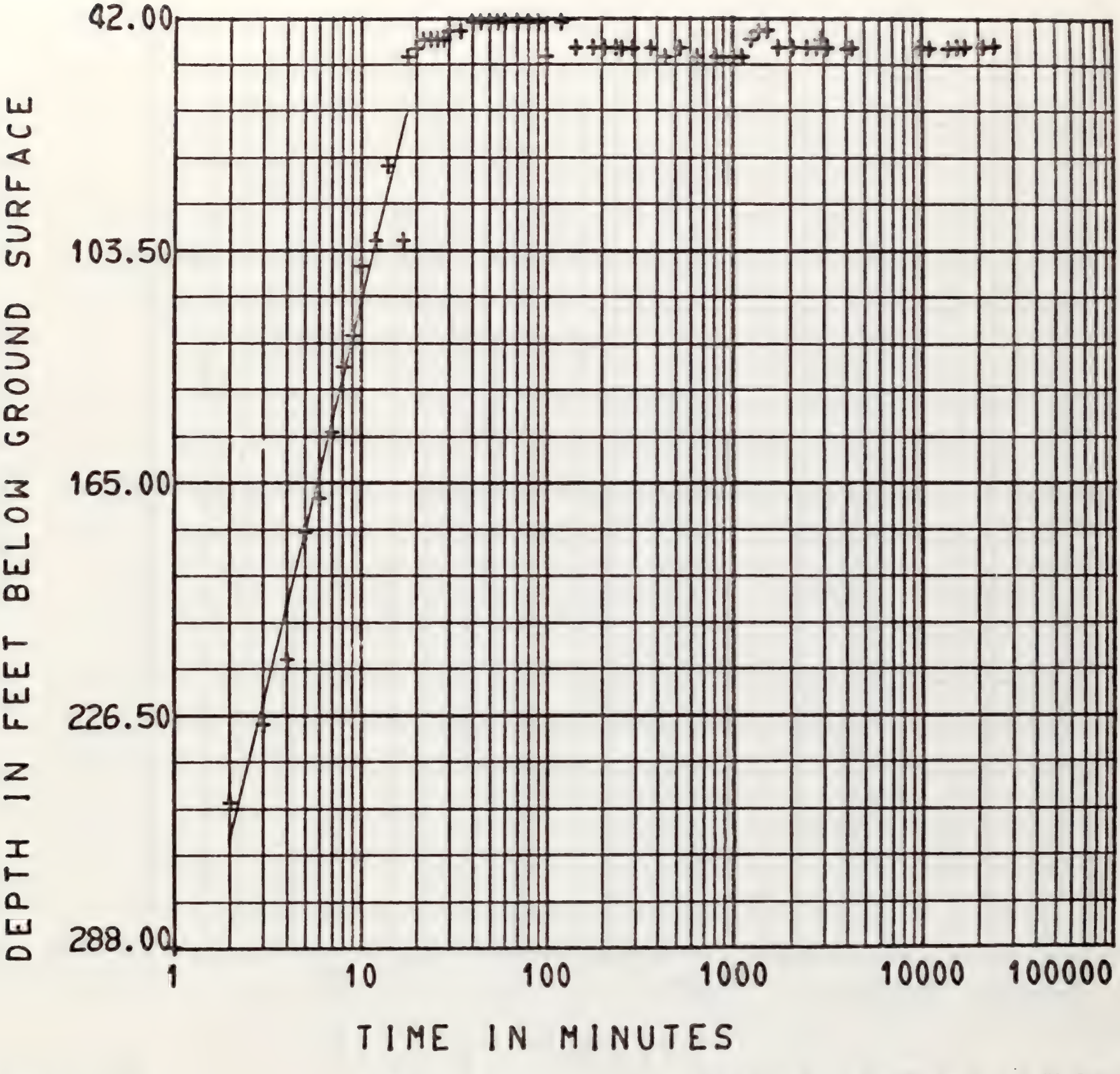
TO-2 GS-19 LOWR DRAWDOWN



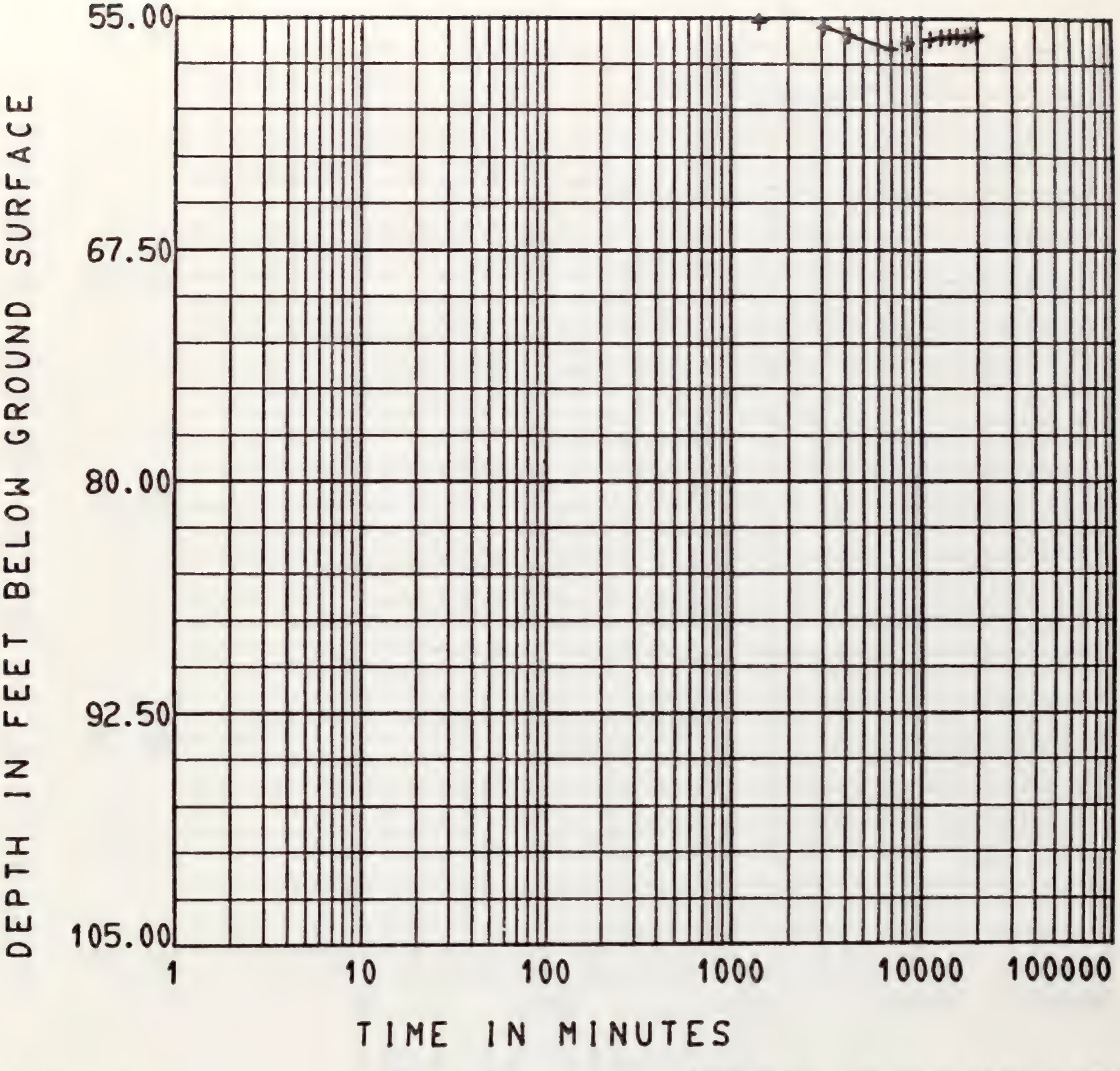
TO-2 GS-19 LOWR RECOVERY



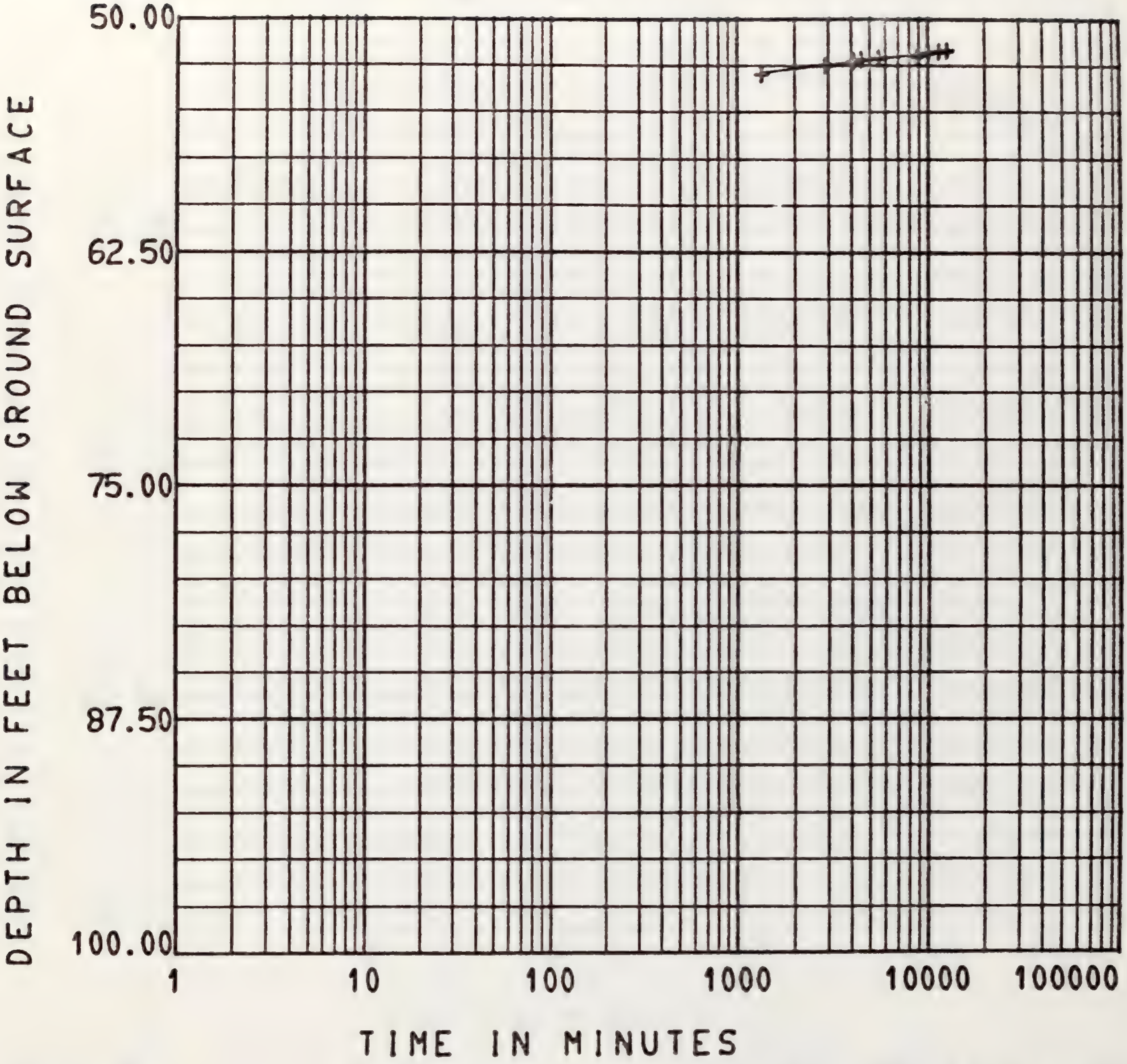
TO-3 TO-3 UPPR DRAWDOWN



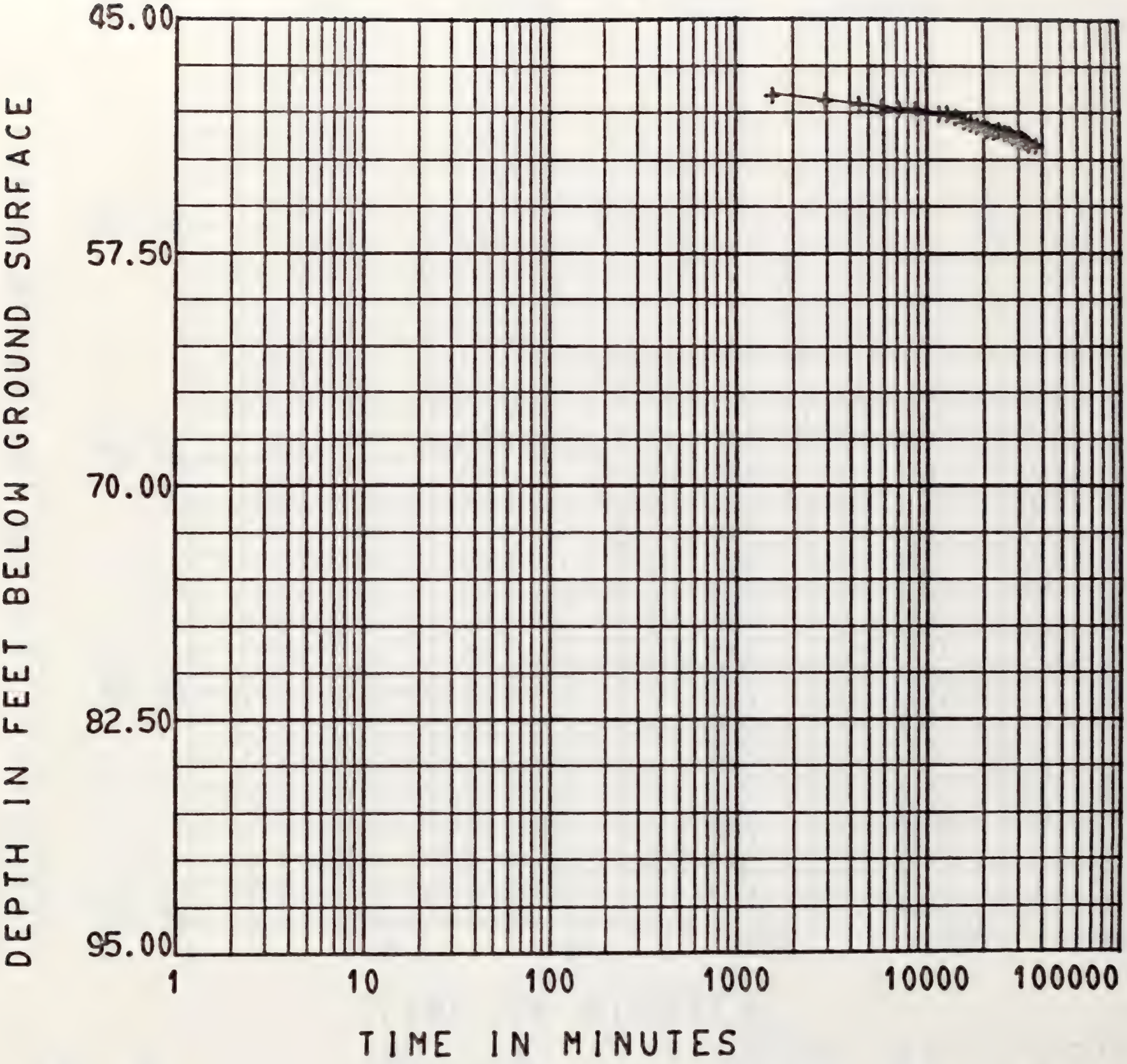
TO-3 TO-3 UPPR RECOVERY



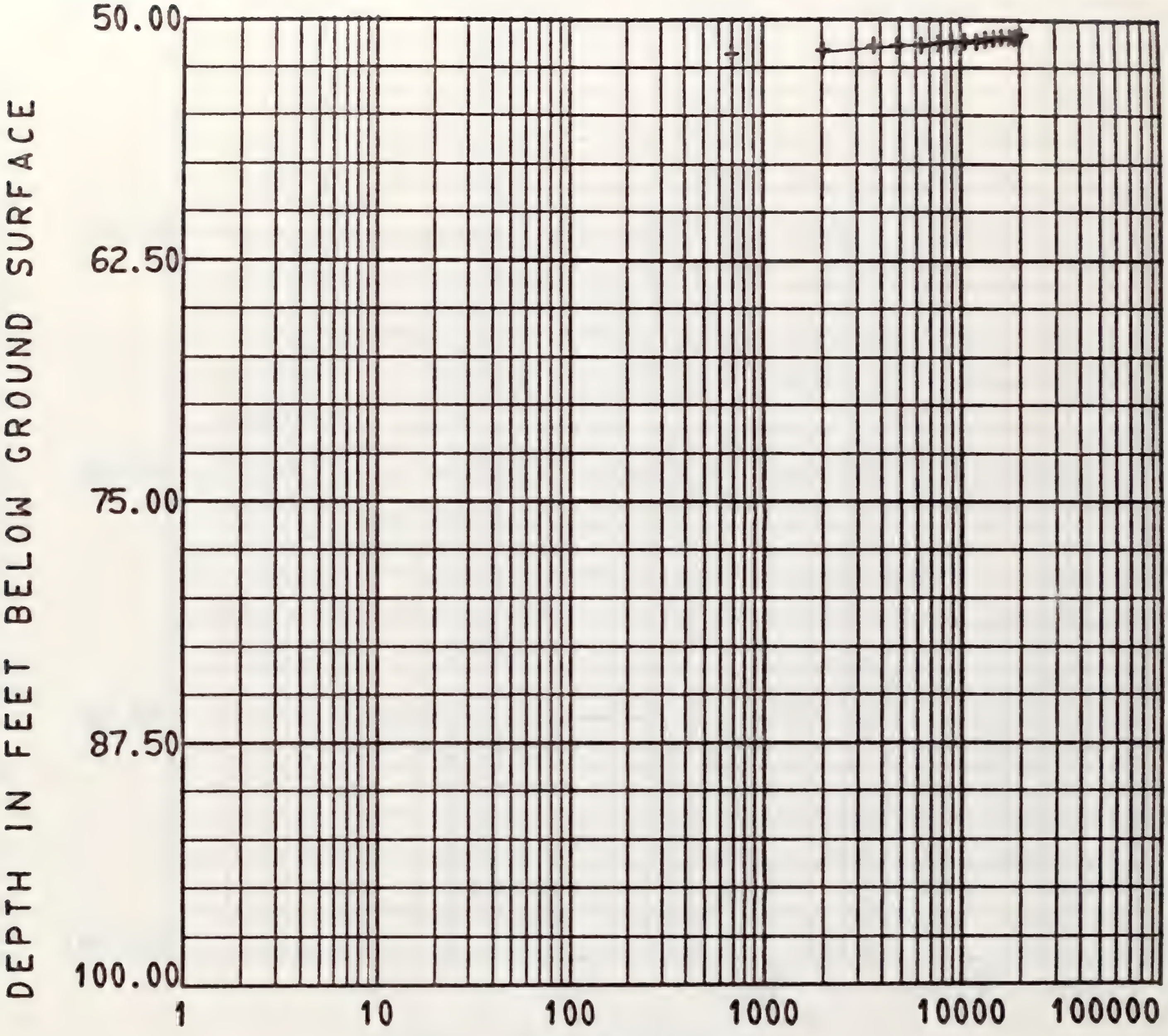
TO-3 GS-18 UPPR DRAWDOWN



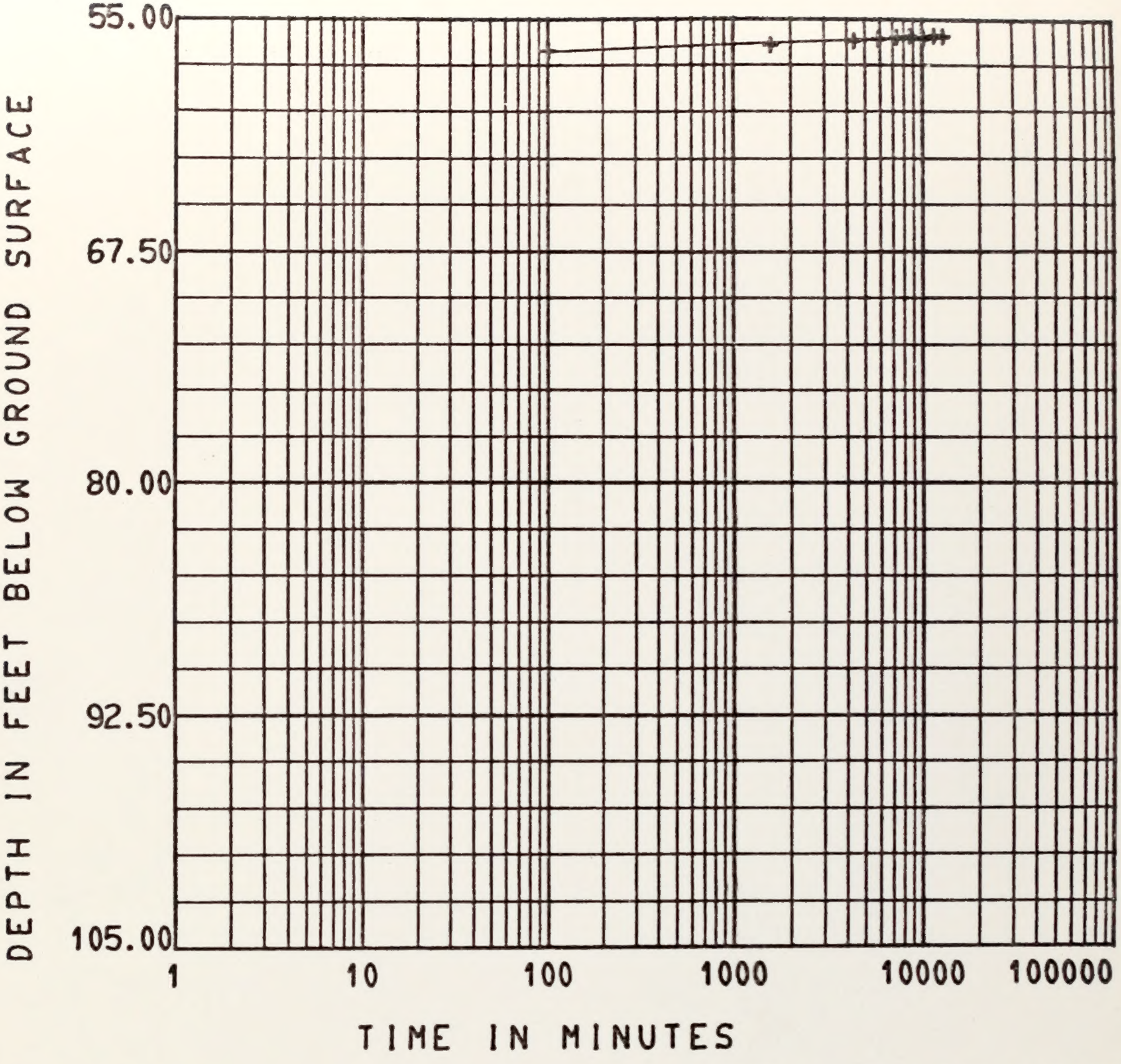
TO-3 GS-18 UPPR RECOVERY



TO-3 GS-19 UPPR DRAWDOWN



TO-3 GS-19 UPPR RECOVERY



TO-3 GS-19 UPPR RECOVERY